1300 INSTALLATION OF STREET LIGHTING EQUIPMENT AND TRAFFIC CONTROL DEVICES

The following Specifications and provisions apply to the construction of all Street Lighting and Traffic Control Systems.

Item 1301 Description

This specification covers the details of equipment, material, appurtenances and the labor necessary for the installation of a complete, first-class Street Lighting and/or Traffic Control System. This work covers the furnishing and installing all Lighting, Traffic Signal and Signing Equipment ready for service at the locations shown on the plan and in accordance with the details or as ordered by the City Traffic Engineer. The work also includes necessary excavation and backfill, disposal of discarded materials, restoration of disturbed facilities and surfaces and electrical testing as specified.

In addition the work requires maintaining existing traffic and lighting facilities throughout the life of the Contract period. This also includes installation of any temporary lighting, traffic signals or signing where specified in the plans.

Equipment specified as being furnished by the City will be available as indicated herein and installed by the Contractor.

Item 1302 References

Wherever reference is made herein to any other specification or standard, it means the latest revision thereof in effect at the time of invitation to bid. This specification will govern where a reference specification and this specification disagree.

AASHTO numbers refer to the standards issued by the American Association of State Highway and Transportation Officials, Washington, D.C. 20001.

AISI numbers refer to standards of American Iron and Steel Institute, Washington, D.C. 20036.

ANSI refers to American National Standards Institute, Inc., New York, New York 10018.

ASTM numbers refer to designation numbers of standards issued by American Society for Testing and Materials, Philadelphia, Pennsylvania. 19103.

AWPA numbers refer to the specifications issued by the American Wood Preservers Association, Stevensville, Maryland. 21666.

AWS numbers refer to the specifications issued by the American Welding Society, Miami, Florida 33135.

EEI numbers refer to standards of Edison Electric Institute, Washington, D.C. 20036.

Federal Color Numbers refer to Federal Standard No. 595 issued by the United States Government, General Services Administration, Business Service Center, Region 3, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Depot, Washington, D.C. 20407. Color chips are available from this source.

IEEE numbers refer to standards of the Institute of Electrical and Electronic Engineers, New York, New York 10017.

IES numbers refer to standards of Illuminating Engineering Society, New York, New York 10017.

ITE refers to the Institute of Transportation Engineers, Washington, D.C. 20024.

IMSA numbers refer to the specifications issued by the International Municipal Signal Association, Fort Worth, Texas 76112.

ICEA numbers refer to the specifications issued by the Insulated Cable Engineers Association, South Yarmouth, Massachusetts 02664.

NECA refers to National Electrical Contractors Association, Bethesda, Maryland 20814.

NEMA numbers refer to standards of National Electrical Manufacturers Association, Washington, D.C. 20037.

The Ohio Manual of Uniform Traffic Control Devices for Streets and Highways referred to herein is available from the Ohio Department of Transportation, Division of Highway Operations, Office of Traffic Engineering, 1980 West Broad Street, Columbus, Ohio 43223. Part 7 is available as a handbook.

REA numbers refer to the specifications issued by the Rural Electrification Administration, Washington, D.C. 20250.

VTCSH standard (definition).

UL Listing refers to the Standards of the Underwriters Laboratories, Inc., Chicago, Illinois 60611.

The State of Ohio, Department of Transportation, Construction and Material Specifications and the current issue of the City of Cincinnati Supplement to said current issue of the State of Ohio Specifications will be available at the office of the City Engineer including any supplements and/or changes thereto. Item numbers referred to herein will reference to the State of Ohio Specifications and City of Cincinnati Supplement.

Item 1303 Materials

1303.01 Materials In General. All equipment and materials will be new, of first quality, of current design, proven in service, and free from defects and poor workmanship. Underwriters Laboratories, Inc. requirements apply to electrical equipment in general. The Institute of Transportation Engineers (ITE) requirements apply to traffic signal equipment. The National Electrical Code and local codes for the City of Cincinnati also apply to equipment and materials. Experimental or untried equipment is not acceptable.

All electrical parts, wire, switches and other elements of the installations require ample capacity to carry the required current without excessive heating or causing an excessive drop of potential

Install a nameplate, indelible marking or brand identifying the type, model, catalog number and manufacturer on each individual item of equipment except as otherwise provided herein.

The City may request samples of equipment and materials supplied by the Contractor for testing and evaluation.

1303.02 Guarantee. Replace and install free of charge to the City, any material furnished by the Contractor that fails in any manner by reason of defective material or workmanship within a period of one year from the date accepted by the City, or the manufacturer's standard warranty, whichever is greater. Warrant performance as advertised and suitability for intended use.

1303.03 Damaged Materials. Be responsible to not scratch or damage the paint or galvanized finish on any materials or equipment installed. Touching up minor scratches with two coats of a zinc touched up rich base paint matching the final paint color. The City will not accept major deep scratches on galvanized finishes on poles or other equipment.

Item 1304 Utilities, Permits and Regulations

1304.01 Utilities. Contact the Ohio Utility Protection Service (OUPS), and comply with all OUPS regulations before excavating. Regardless of surface markings for underground utilities, exercise extreme caution in all areas where underground activities are known to exist.

Consult and cooperate with the Cincinnati Gas and Electric Company and the Cincinnati Bell Telephone Company in order to provide attachments to each company's respective poles.

Comply with the National Electrical Safety Code Standards for Utility Line clearances on poles and maintain the following clearances:

Utility	Minimum Clearance	To
Telephone, Telecommunications and/or Cable TV	40 inches (1 meter) Below	Proposed 120/240 volt traffic signal and/or street (low voltage)lighting cable
	12 inches (305 mm) Below	Proposed low voltage CTCS tri-cable
Cincinnati Gas & Electric Company 120/240 volt Secondary System	16 inches (406 mm) Above	Proposed 120/240 volt traffic signal and/or street lighting equipment
	40 inches (1 meter) Below	Proposed low voltage CTCS tri-cable
Cincinnati Gas & Electric Company Primary System	6 feet (1.8 meters) Above	Proposed 120/240 volt traffic signal and/or lighting cable and equipment

Maintain a minimum clearance of 27 feet (8.23 m) between the cable and the tracks, where installing cable over railroad tracks. Guy or tether traffic signals and signs installed on spans crossing at railroads with additional messenger cable to prevent equipment from swaying within 12 feet (3.7 m) of the track rail. Maintain a ten-foot (3.05 m) "working" clearance at all times around Cinergy's primary power system. Notify Cinergy and the Engineer before working within the ten-foot (3.05 m) zone to ensure proper protection of high voltage cables.

1304.02 Permits. Comply and obtain permits specified in 107.04.

Where Contracts are exclusively for the installation of traffic signal and/or street lighting equipment and bids are let through the City's Purchasing Department, the City may provide marked prints, which indicate existing utilities. The Contractor may use such drawings for the purposes of expediting the permit process.

1304.03 Regulations. Perform all work in accordance with he laws, codes and regulations established by the City of Cincinnati.

Conform to the latest edition of the National Electrical Code and the National Electrical Safety Code, in addition to local codes.

Item 1305 Coordination

Do not remove any operating traffic signal or other equipment from service without seven days prior notification to the Engineer. To resolve any problems that may arise, the Contractor's supervisor of construction must consult with the Engineer before and during construction.

Provide thirty days advance written notice to both the Engineer and the city Traffic Engineer on devices specified to be furnished by the City of Cincinnati for Contractor's installation. (See Item 1308.)

Within seven days after procuring equipment for the City, perform installation and operation of controllers. At its discretion, the City may withhold the furnishing of control equipment to the Contractor for any locations that are not complete and ready to operate or for which catalog cuts have not been approved.

Item 1306 Working Plans

Within reasonable time, submit to the Engineer and the City Traffic Engineer for review and approval eight sets of drawings, catalog cuts, specifications, brochures, data sheets, wiring drawings, etc., of apparatus and equipment the Contractor proposes to furnish. Show clearly on all submitted documents the design, quality, dimensions, and other such information as may be necessary for a proper evaluation of the items submitted. On all submitted documents, identify the specific project number, name and year with the bid item reference number to which the apparatus or equipment applies. If more than one catalog number or type is listed on a sheet, indicate the item intended to be furnished by underlining, circling, or otherwise marking.

The City will reject any items failing to comply with specification requirements. Do not purchase or install any of the items until receiving written approval from the Engineer. The Engineer's approval of working plans does not relieve the Contractor of responsibility for erroneous or inconsistent dimensions, notations, omissions or other errors, or the proper functioning of the completed installation. After the Engineer approves such plans are considered supplemental, but in no sense as a substitute for, the original plans.

Item 1307 Standard Drawings

Standard Detail Drawings in booklet form showing accepted installation practices and fabrication requirements will be available at the Division of Traffic Engineering, 801 Plum Street, Cincinnati, Ohio 45202.

Conform with these standard details where such details are not provided on the plans on all equipment and installations the Contractor furnishes.

Item 1308 Equipment Furnished by the City

Provide all labor, materials and equipment for the complete installation of street lighting circuits and/or traffic control systems in accordance with the plans, details and specifications, except equipment specified as "**Installation only**" or "**Item 1308.01 Equipment to be Furnished by the City**."

Where the Contract specifies any equipment as **installation only** or **furnished under Item 1308.01**, the City will furnish such equipment requiring Contractor assembly and installation. The City will make payment as indicated in Item 1308.01. Furnish all other hardware, material and incidentals necessary to provide the assembly complete and ready to install.

Depending on the extent and nature of the Contract Work, the City may elect to require the Contractor to furnish all equipment or may provide some or most of the equipment to the Contractor.

The following guidelines generally apply; however, they may be modified depending on the Contract and availability of City-owned equipment.

A. Where Contracts are based on unit price bids, the City will furnish only that equipment specified in the Contract bid item as **Installation only.**

B. Where traffic signal and/or street lighting installations are bid on a lump sum basis, the City will furnish all equipment as listed under Item 1308.01.

This Contract includes complete specifications for all equipment regardless of whether the City or Contractor furnishes same.

1308.01 Equipment Furnished by the City. Where the Contract specifies that the City will furnish equipment under Item 1308.01, the Contractor will provide some or all of the following equipment and accessories:

A. Steel anchor base and/or embedded base poles and posts, including lighting bracket arms, anchor bolts and nuts.

B. Wood poles.

C. Vehicular and lane use traffic signal heads. Assemble the signal and furnish all other hardware and materials to provide the signal head complete and ready for installation. Furnish all signals with lamps.

D. Pedestrian signal heads, including lamps.

E. Illuminated signs, including lamps and plastic face.

F. Traffic signal controllers, complete with cabinet and with all internal timings setup. Install, and furnish all hardware and incidentals, and connect all signals, un-energized interconnect and power cables.

G. Detector amplifiers and video detection equipment.

H. Island lights including fixture, globe and lamp, not including hardware for mounting to the post.

NOTE: Furnish and install all mounting or hanging hardware and incidentals to complete the installation.

This item may include other equipment not indicated herein. Provisions of the Contract bid proposal would specify such equipment.

The City will furnish the equipment to the Contractor at the Traffic Services Bureau's Storeroom at 3300 Colerain Avenue Building 250 - Cormandy, Cincinnati, Ohio 45225, and will equip the Contractor only with those accessories this item indicates.

The Contractor loads all equipment into its own vehicles. Payment for hauling and loading equipment shall be incidental to the item.

Be responsible for all equipment furnished by the City.

In addition to the 30 days advance written notice, provide an additional five days oral or written notice as a reminder prior to picking up equipment. This is included in the 30 days notice.

Item 1309 Installation Practices

1309.01 Lateral Roadway - Structure Clearance. Maintain a minimum of two feet (610 mm) clearance between face of curb and face of pole, pedestal, post, cabinet or equipment attached thereto.

1309.02 Equipment Installation Practices. Install all traffic control devices on a span wire and/or a mast arm(s) for any approach with a level appearance of the lowest part of all the equipment facing the approach, and maintain a minimum clearance of 17 feet (5.18 m) to grade or as plans and specifications specify.

1309.03 Signal and Sign Adjustment. Adjust and perform minor repositioning of signs and/or signals as directed by the City Traffic Engineer. Payment includes cost of the installation of the equipment.

Item 1310 Definitions

Specified. Wherever "specified" is used herein, it means "specified" in the invitation to bid and/or order to Contract.

Signal Section or Optical Unit. That part of a traffic signal consisting of a housing with a lens, reflector and lamp for displaying a signal color.

Signal Face. The assembly of signal sections used to display complete signal indications to one approach of traffic.

Signal Head. An assembly of one or more signal faces, each oriented to an approach of traffic, and all attached to one mounting.

Signal Indication. The illumination of a traffic signal lens (or two lenses concurrently when required) in a signal face for an approach of traffic.

Beacon. A traffic signal consisting of one section and used for flashing operation.

Optically Programmed Signal. Signal head containing optical units projecting an indication, which may be selectively veiled so as to be visible only within desired boundaries.

Sag. The amount of deflection at the lowest point of span wire used for the mounting of signal heads.

Detector. A device used to register the passage or presence of vehicles or pedestrians.

Pedestrian Pushbutton. A detector used at crosswalks for the purpose of registering pedestrian calls to a traffic control unit.

Loop. One or more turns of pavement-embedded insulated wire used to establish a zone of influence for the detection of vehicles.

Loop Detector Amplifier. A device for amplifying the signal generated by the passage or presence of a vehicle over a loop.

City Traffic Engineer. The City Traffic Engineer of the City of Cincinnati or his or her duly authorized representative. Where the Contract is by and under control of the Traffic Engineering Division, the "Engineer" shall mean the City Traffic Engineer.

Item 1311 Inspections

1311.01 Responsibilities. In addition to the provisions of Item 105.11, responsibilities are as follows:

A. The Engineer approves all trenched conduit before the Contractor backfills and completes concrete encasement.

B. The Engineer approves all pullbox installations before backfill.

C. The Engineer approves all foundations for anchor base poles and posts, complete with conduit, anchor bolts and rebar cages intact, prior to concrete pour.

D. The Engineer inspects and approves all locations the Contractor stakes prior to any excavations.

Item 1312 Electric Power Service

1312.01 Power Source. Obtain electrical power from Cinergy, Cincinnati, Ohio. Obtain the local power service where plans specify at the designated service pole (SP). Consult and cooperate with the Traffic Services Bureau and Cincinnati Gas and Electric Company to provide service.

Traffic Services Bureau will make final service connection application to Cinergy after inspection. Traffic Services Bureau will make such inspection within two full working days of Contractor's request.

1312.02 Electrical Energy. Electric power required is a 60 Hertz, single phase 120 volts - two wire system for traffic control equipment, and, unless otherwise specified, a 240 volt - three wire system for street lighting equipment.

NOTE: Cinergy crews will make electrical connections to any Cinergy power source. The Contractor must strip the neutral cable of insulation up to the point of entry into a conduit riser or pole.

1312.03 Power Service. Power service consists of equipment installed as detailed to provide pole attached raceways and disconnect switch for use with power cable routed from the service pole to the lighting circuit and/or the traffic signal controller.

Raceways include the specified weatherhead and conduit risers, with all necessary hardware. Terminate conduit risers at the disconnect switch enclosure. From the switch enclosure connect with underground conduit or conduits to the specified pole or pullbox. Where using a steel pole, Contractor may use the interior of the pole instead of external conduit for the power cable raceway.

Meet the requirements of 1321.06 for materials and installation of the weatherhead and conduit risers. Furnish sizes as shown on the plans and details.

Conform to Item 1321.04 for steel conduit requirements. Conform to Item 1321.04 for PVC Type II conduit requirements.

Disconnect switch means a safety switch or street lighting controller per Item 1324.03 as the plans specify. When mounted on a pole, mount the switch so that the bottom of the disconnect switch is a minimum of eight feet (2.44 m) above grade, unless otherwise noted on the plans.

Install two 3/8 inch (9.5 mm) drain holes in the bottom of the switch enclosure.

Ground all non-current carrying metal equipment enclosures to the pole ground cable, or in the case of steel poles, the pole ground nut as shown on the details and as Item 1320.01 indicates. Verify that the pole ground cable is continuous to ground.

Where electric power is indicated on a pole remote from the pole housing the disconnect switch, furnish and install an overhead service cable per Item 1323.01 connecting the two poles, including all accessories and hardware.

Power service may be specified as a single pay item which includes all items listed under section 1312.03, or items required to provide power service may be individually specified bid items.

Furnish and install the weatherhead and conduit risers disconnect switch (1324.03), underground conduit, power cable, service cable (where the Contract specifies) and all hardware and connections.

1312.04 Service Pole. Where the Contract specifies, furnish and install a wood pole of the correct size in conformance with the requirements of Item 1318.04. This item of work includes furnishing and installing a ground wire secured on the pole as plans indicate, and providing and installing a ground rod, all in accordance with Item 1320.02.

1312.05 Basis of Payment. The City will pay for accepted quantities at the Contract price as follows:

Item	Unit	Description
1312	Each	Power service
1312	Each	Service pole

Item 1313 Testing

1313.01 General. Perform testing in conformance with the requirements of Item 625.22, with the following exceptions:

A. Cable Insulation Tests for Traffic Signal Equipment. Measure the insulation resistance for each conductor (including spares) of cable or wire terminating at the controller cabinet. The City requires insulation resistance exceeding ten megohms prior to acceptance. Measure insulation resistance for the wire of roadway loops before and after embedding the wire with sealant in slots. Furnish test results listing the resistance readings for each conductor.

Connect all cabinet wiring in accordance with the wiring diagram after completion of the cable insulation. Demonstrate to the satisfaction of the Engineer that all circuits are continuous and operating correctly with freedom from shorts, crosses and unintentional grounds.

B. Performance Test for Traffic Signal Equipment. Prior to acceptance, operate the traffic control system continuously for ten consecutive days without interruption from malfunctions or failures.

At new signal locations on facilities opened to traffic, place the signal on flashing operation for a minimum period of seven days prior to the testing and subsequent operation of the signal unless directed otherwise by the Engineer.

During the period of testing, if vehicle or pedestrian traffic is in current use, maintain the equipment except for the traffic controller. The City of Cincinnati maintains the traffic controller. In the event of any malfunction of the equipment the Contractor installs, the City will make repairs on an emergency basis. The City will charge the Contractor the cost of repair based on actual labor cost plus 50 percent, actual material cost plus ten percent for handling, established cost per hour of the trucks and equipment required in addition to approximately 50 percent of total cost to cover overhead (administration of billing and accounting).

During the test period at intersections where pedestrians and vehicles are not using the traffic signal equipment the Contractor installs, correct malfunctions of the installation with the exception of failure of the traffic controller.

Immediately replace any failed lamp; lamp replacement does not require a restart of the test. Furnish test results including the method and date of correction of each fault, and the beginning and end of the ten-day test.

C. Performance Test for Lighting Equipment. Prior to acceptance, operate all new lighting equipment continuously for a period of five days (120 hours). Immediately replace any failed equipment or components. Replacing any failed equipment or components does not constitute a restart of the test. However, should the number of failures be substantial in the judgment of the Engineer, the test may extend until such time as the Engineer determines that the system is satisfactory.

1313.02 Acceptance. Upon acceptance of the project, transfer to the City all Manufacturers' guarantees or warranties covering installed electrical or mechanical equipment. For electronic control type and special equipment, furnish three copies of wiring diagrams, a service manual and instructions on installation and maintenance for each different type, model or system of equipment used on the project.

Notify the City Traffic Engineer or his or her authorized representatives and meet with them on the site when the new traffic signals are turned on color. Provide records indicating the time and date of both the start of the flashing operation and full color operation.

1313.03 Testing and Acceptance of Controller Installations. Provide certification of all controller installations for all locations where the Contractor sets up, tests and installs traffic signal controllers prior to final release.

Perform final test consisting of 30 minutes of operation without failure of the controller or incorrect color sequence operation before acceptance. Should any malfunction occur as the result of poor workmanship, make all necessary repairs on site.

Should the controller malfunction within 60 days of the final test due to poor workmanship on the part of the Contractor, the City will bill repairs for such work to the Contractor. The City

will charge the Contractor the cost of the repair based on City charges as outlined in paragraph 1313.01.B.

Item 1314 Maintenance of Traffic and Systems

1314.01 Maintenance of Traffic. In addition to the requirements of Item 614 "Maintaining Traffic" in the ODOT CMS and the modifications thereto in this Supplement, the following apply:

Provide adequate and safe traffic control at locations under this Contract utilizing advance warning devices, police, flagmen, labor and materials consistent with the Ohio Manual of Uniform Traffic Control Devices, and which the City approves.

Submit a plan or plans for the maintenance of traffic to the City. Such a plan or plans must meet with the approval of the Division of Traffic Engineering. Submit the plan at least five days in advance of any Contract work at the location(s) involved.

Provide police in assistance of traffic maintenance and control during the periods where the traffic signals may have to be turned out at all locations the City Traffic Engineer deems necessary.

Disable no more than one traffic signal location for the purpose of Contract work at any time where more than one of the specified locations are on the adjoining major street and are adjacent to one another, unless the City Traffic Engineer approves in writing.

The City will provide regulatory traffic control devices, such as temporary stop signs upon five days advance notice.

Do not work at any location during the hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M., Monday through Friday, or as the Contract bid proposal provision indicates.

Should for any reason the Contractor be unable to comply with the provisions of his Contract, the Engineer shall impose special requirements as may be necessary for the safety and convenience of the public. Special requirements may include, but shall not be limited to: a) services of an off-duty Cincinnati Police Officer(s), b) work on a continuing basis, or c) temporary restoration or plating.

1314.02 Maintenance of Existing Street Lighting Circuits. Maintain the existing street lighting system in operation until the City tests and accepts the new circuit(s). Maintain the existing circuits using temporary wiring or by scheduling installation of new equipment so as not to disturb the existing circuit.

The Contractor is responsible for any damage to any of the street lighting components due to the Contractor's operations.

The City of Cincinnati is responsible for normal maintenance of the street light system(s), including lamp replacement, maintenance of the control equipment and repairs required due to outages caused by circumstances other than the Contractor's operations.

Should construction of the new street lighting circuit necessitate removal or de-energization of all or part of the existing street lighting circuit, maintain lighting on one side of the roadway or seek approval to provide temporary lighting during construction. Do not leave the roadway purposely unlit under any circumstances.

Obtain approval of the City Traffic Engineer for any proposed method for maintaining the lighting system.

1314.03 Maintenance of Existing Traffic Signal Installations. Keep the existing traffic signal in operation until the new signal is operational. Reinstall existing items to be incorporated into the new traffic sign after completing all other new work which can be done prior to the relocation work. Cooperate with the Engineer and make all temporary signal adjustments as the Engineer directs.

The City of Cincinnati is responsible for normal maintenance of the traffic signal system(s), including lamp replacement, maintenance of the control equipment and repairs required due to outages caused by circumstances other than the Contractor's operations. The Contractor is responsible for any damage to any of the traffic signal components required to be handled during relocation of poles and modifications to the signal system. Plan any changes to reduce signal down time to two hours maximum. Cover or remove all unused traffic or pedestrian signal heads.

Schedule the construction of the traffic signal installations to maintain the interconnect system throughout the Contract. Use existing interconnect cable, temporary cable, or newly installed interconnect cable to maintain the interconnect system.

At installations where interconnect cable does not exist, install the specified new interconnect cable system prior to completing and operating new or reconstructed traffic signal systems, or provide, subject to the Engineer’s prior approval, an equivalent approved means of maintaining coordinated signal operation at all times.

1314.04 Performance. If in the opinion of the City Traffic Engineer, the Contractor does not provide proper maintenance of traffic facilities and proper provisions for traffic control, the City may take the necessary steps to place them in proper condition, and bill the cost of all labor and materials by City personnel to the Contractor.

1314.05 Basis of Payment.

A. The City will make payment for Item 1314.01 "Maintenance of Traffic" in accordance with and under Item 614. Include all labor, materials, temporary signs, cones, barrels, barricades, flashing arrow barricades, flagmen, police and all control devices, equipment and incidentals.

B. The City will make payment for Items 1314.02 and 1314.03 at the unit price bid per each street lighting circuit and maintenance of traffic signal location, including all labor, material, tools, equipment and incidentals.

Item	Unit	Description
614	Lump Sum	Maintenance of Traffic
1314	Each	Maintenance of Existing Street Lighting Circuit
1314	Each	Maintenance of Existing Traffic Signal Location

Item 1315 Temporary Systems

1315.01 Temporary Street Lighting. Provide temporary lighting where specified and where the existing lighting system is in the way of construction and Contractor must remove prior to the installation of the proposed new lighting circuit(s).

Submit a plan for approval to the City Traffic Engineer indicating the methods, materials and equipment to be used.

Temporary lighting is to provide a minimum of one foot candle (10 lx) maintained, unless otherwise noted in the Contract Documents.

Install temporary lighting on existing or new wood or steel poles. Conform to the National Electrical Code and the National Electrical Safety Code, with no exposed wiring or material, which could be hazardous to pedestrians or motorists in the area. Mount luminaires with sufficient mounting height in order to reduce glare to a minimum.

Maintain and assume responsibility for the temporary lighting circuit(s) until the proposed new lighting circuit is operational. Respond to and correct any outages within 24 hours of notification.

1315.02 Temporary Traffic Signal Installation. Where the Contract specifies, install a "temporary" signal system(s) as a complete installation at a unit price bid per each intersection.

Install all equipment and materials the plans show and detail, and furnish all items except those specified "installation only" or as Item 1308.01 specifies. Furnish materials and equipment in accordance with all of the provisions and specifications for permanent signal systems as indicated herein.

1315.03 Method of Measurement. The City will measure temporary street lighting as a complete unit in place, including testing and accepting all wiring, luminaires, poles, brackets, conduits, risers, control equipment and all materials as necessary to provide an operational and satisfactory system.

The City will measure temporary traffic signal installations as complete units in place, including all testing and accepting all signals, signs, detectors, poles, wiring and materials necessary to provide a complete and operational system.

1315.04 Basis of Payment. Include the cost of electrical energy and all labor, materials, equipment and incidentals necessary to install, maintain and subsequently remove the temporary system(s).

Item	Unit	Description
1315	Lump Sum	Temporary Street Lighting
1315	Each	Temporary Traffic Signal Installation, by location

Item 1316 Removal of Existing Equipment

1316.01 Removal of Existing Street Lighting Equipment. Remove existing poles, brackets or other arms, fixtures, foundations, pull boxes, cable equipment, control equipment and materials which are not slated for reuse in new installations in accordance with Item 202. Unless the Contract specifies otherwise, abandon conduit and underground cable. Deliver removed reusable equipment to the Traffic Services Bureau, 3300 Colerain Avenue, Cincinnati, Ohio 45225.

Where the Contract specifies partial removal of foundations, remove foundation including anchor bolts to a minimum of five inches (127 mm) below proposed finished grade, unless otherwise specified in the Contract Documents. Finish level to existing pullbox, paved area or other as specified with Class C concrete. Fill exposed conduit entries with Class C concrete.

1316.02 Removal of Existing Traffic Signal Installation, by Location. In accordance with Item 202, include the removal of the signal heads, controller, detectors, strain poles, pole foundations, cables, messenger wires, conduit, pullboxes, and all other portions of the existing traffic signal not slated for reuse in the new installation.

With the exception of items to be relocated and incorporated into the new installations or whose removal is otherwise necessary to permit the installation of the new signal equipment, remove no items until the new installation is in full operation unless the Engineer directs otherwise.

Remove and reinstall reusable items as part of the new signal installation under items further noted as "relocated".

All other items, except those noted under the bid proposal's provisions as removed and returned to the City of Cincinnati, become the property of the Contractor. Remove and lawfully dispose of those items.

1316.03 Removal of Existing Interconnecting Cable. Where new interconnecting cable replaces existing cable, payments for removal of existing cable (including existing messenger cable, sectionalizers and hardware) are incidental to the installation of new cable. The estimated linear feet of cable to be removed are indicated in the quantities.

1316.04 Removal of Existing Equipment, by Item. Where specified by item, remove the equipment indicated. Return reusable equipment to the City's Traffic Services Bureau, 3300 Colerain Avenue Building, Cincinnati, Ohio 45225. Dispose of all unusable material(s) lawfully.

Include all mounting hardware, incidentals and accessories supporting or part of the equipment, which the Contract does not specify to be retained in equipment to be removed. Included with this item of work is the required modification of existing hardware, wiring or rewiring to maintain the existing equipment the Contract does not specify to be removed, intact and operational.

Where removing equipment as part of an electrical assembly, also remove all existing debris and dirt.

1316.05 Removal of Existing Poles. Remove all embedded poles the Contract does not specify to be used, to a minimum depth of one foot (305 mm) below existing grade. Include foundation removal in all anchor base poles the Contract specifies for removal. Backfill all excavated foundation holes and openings with low-strength material meeting the requirements of 613.

Return all salvageable and reusable anchor base and embedded base poles to the City Traffic Engineering Division's pole yard.

Keep adequate walking areas for pedestrians clear of equipment, materials, supplies and excavated materials at all times.

Move any excavated material obstructing any portion of the sidewalk or street area at the end of the working day, so as not to obstruct the sidewalk or street area.

Remove excavated materials from sidewalk areas, and dispose of lawfully off site.

Neatly restore sidewalks, driveways, and sodded areas to the satisfaction of the City, in accordance with Item 1334.

1316.06 Method of Measurement. The City will measure removal of existing equipment as a complete unit, by circuit, location, or by item as the Contract specifies, including all excavations, restorations, backfilling, disconnections, removal of hardware and debris and incidentals necessary to remove each item complete and clear of adjacent equipment specified to be retained.

1316.07 Basis of Payment. Payment is full compensation for furnishing all labor, materials, equipment and incidentals required to completely remove the item or equipment specified, including restoration. The City will pay for accepted quantities at the Contract price as follows:

Item	Unit	Description
1316	Lump Sum	Removal of Existing Street Lighting Equipment
1316	Each	Removal of Existing Traffic Signal Installation by Location
1316	Each	Removal of Existing Equipment, by Item
1316	Each	Removal of Existing Poles

Item 1317 Painting

Paint traffic signal and street lighting equipment, in accordance with 514 where applicable, except as modified herein.

Furnish all labor and material to complete this item of work. Include payment with the item painted.

Where the Contract specifies, use a zinc rich dust primer. Use alkyd resin exterior enamel finish coat.

Spot prime, prime coat and finish coat galvanized surfaces, poles, exposed conduit, brackets, drop pipes, and cabinets.

Spot prime where cuts are made into steel material with soya-alkyd primer with at least 60 percent pigment by weight being zinc dust, "Zinc It" (cold galvanizing coating) by CRC Chemical Company, or approved equal.

Paint both inside and outside of wood tree mouldings with two coats of hot linseed oil. Polycarbonate housings need not be painted.

Apply paint in the field only when the ambient temperature is above 50° F (10° C), and the surface to be painted is dry.

The following are approved finish colors, unless otherwise specified:

Item to be Painted	Finish Color
Traffic Signal Poles	Mallard Green, UNO
MPL/T – MOL/T Poles	Cincinnati MOLT Pole Beige
Street Lighting Poles	Black or Green for Parkways Black or Green as Indicated for Parks Gray in all other areas
Vehicle and Lane Use Signal Heads	Black on backs Black Inside and Outside on Visors Yellow on Front and all Other Areas
Pedestrian Signal Heads	Black on visors Black UNO
Pedestrian Pushbutton Housings	Yellow
Internally Illuminated Signs	Black UNO

Colors of paint shall be in accordance with Federal Standard No. 595. Color Nos., as follows:

Color Name	Federal Color Number
Pole Gray	16251
Pole Green	14062
Highway Yellow	13507
Highway Green	14109
Gloss Black	17038
Gloss White	17875
Beige	20372
Semi-Gloss Black	27038
Semi-Gloss White	27875
Lusterless Black	37038
Lusterless White	37875
Mallard Green	Sherwin Williams #SW2392

Item 1318 Poles and Supports

1318.01 Steel Poles.

A. General. This item includes the fabrication and installation of steel lighting poles with bracket arms, signal strain poles, signal arm support poles and combination lighting and signal poles and others as the Contract specifies.

B. Shafts. Construct all lighting, signal poles and mast arms of tapered tubes of either a true continuous taper or of a sectional type consisting of straight sections with a tapered effect using reducers or by swaging. Provide circular tubes. Measurements of circular tube diameter at a specific point along the longitudinal cannot vary by more than 3/16 inch (5 mm).

Taper cannot exceed 0.10 inch (2.5 mm) or more than 0.14 inch per foot (11.7 mm/m). Do not include the portion of embedded base poles below groundline in determining taper.

Conform to plan specifications and details for pole and arm length, diameter, gauge, anchor bolt circle diameter, and anchor bolt size.

Meet the AASHTO "Specifications for the Design and Construction of Structural Supports for Highway Signs" for steel material and have a minimum yield strength of 55,000 psi (380,000 kPa). Provide sectional type poles open-hearth, grade B, black steel pipe per ASTM A-53.

Demonstrate support designs not specifically detailed on the plans to the satisfaction of the City Traffic Engineer, as structurally equivalent to the design the Contract specifies.

Poles and mast arms of the true continuous taper type may be fabricated in two portions joined by overlapping of sections (field joint) with the overlap being at least 1-1/2 diameters as determined by the largest diameter of the outer portion. Assemble sections with a 5/8 inch (16 mm) minimum stainless steel hex head through-bolt. Do not use field joints for poles and arms less than 38 feet (11.6 m) long.

Contractor may use one longitudinal, automatically electrically welded seam on circular poles. Welded seams are to be neat and uniform in appearance and have a thickness not less than the base material and a bead height not exceeding 1/16 inch (1.6 mm). The wall thickness at each pole or arm cross section should be of uniform thickness, except at weld beads. Do not use transverse seams or welds on true continuous taper type poles or arms. Welds must conform to Item 513.21.

Furnish embedded type poles with ground collars at least 3/16 inch (5 mm) thick for lighting poles and 3/8 inch (10 mm) thick for signal strain poles, sleeved over and welded to the pole. Locate the collar on the pole at the point where the pole would protrude above the groundline as the details indicate.

C. Anchor Bases and Bolts. Fit anchor bases for poles with a welded-on cast or plate steel base designed to mount on an anchor bolt foundation as shown; include the furnishing of anchor bolts, nuts, washers and shims. Anchor base steel castings to meet the requirements of Item 711.07. Steel plate bases must meet the requirements of Item 711.01. Weld shafts to base both inside and outside, using continuous welds.

Provide square bases with 4 bolt bolt-circles.

Galvanize anchor bolts in accordance with ASTM A153, with galvanizing extending at least two inches (50 mm) beyond the threads. Furnish individual anchor bolt covers, or cover bases for poles erected in sidewalks, traffic islands, curbed areas, and seeded areas of urban character as Item 659.09 defines, or when the Engineer directs. Use "L" shaped anchor bolts.

D. Loading. Design completed assembled poles to carry the loading as the detail specifies, or on the plan specifying a non-standard size pole, without exceeding the rated deflection, cracking, breaking, deforming in permanent set or failing in any way. Include torsional as well as horizontal and vertical loads and ice and wind loading.

The City Traffic Engineer may require approval of poles furnished in accordance with Item 713.01 tests.

Take the load at yield point of any poles at 18 inches (500 mm) from its top.

E. Mast Arms. The Contract requires quantity and orientation of Mast arms. Provide poles and mast with attachment plates and gussets as the plans detail. Assemble with high-strength bolts as shown, with the connection developing the full moment-resisting capability of the arm. Butt diameter of mast arms must be smaller than the diameter of the pole at the point of attachment.

F. Slip Fitter Arm. Where specified, provide a two foot long (610 mm) by two-inch (51 mm) schedule 40 galvanized steel pipe for mounting luminaires. Weld a 2-3/8 inch (60 mm) I.D. 1/2 coupling, threaded inside, to the pole for attachment of arm.

G. Bracket Arms. Conform street lighting bracket arms, including pole and bracket plates, as shown on the details. Fabricate arms from two inch (51 mm) nominal size galvanized pipe.

Pipe strength must conform to ASTM Designation A53 (ASA-B36.1) or schedule 40 in accordance with ASTM Designation A120 (ASA-B36.20).

Design mast arms using upsweep construction as shown on the details or as the Contract otherwise specifies. The bracket arm assembly, including all connections, must be of sufficient strength to transfer all loads up to the yield strength of the pole shaft without undue deflection. Design arm must support a (minimum) 75 pound (34 kg) luminaire having a projected area of 3.3 square feet (0.3 m^2). Provide a minimum eight-inch (200 mm) length at the end of each arm to receive a slipfitter, mounted luminaire.

Construct bracket arms eight feet (2.5 m) or longer of an upper and lower member securely joined by means of a vertical strut or struts.

H. Transformer Bases. Make steel transformer bases from steel conforming to ASTM A36.

Meet the dimensional requirements of the plans and approved shop drawings for aluminum transformer bases designated on the plans by Styles AT-C, and AT-X. Bases are to transmit the design dead, live, ice and wind loads of the light pole to be mounted on it to the foundation without failure or permanent deformation. Comply with the frangibility requirements the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" specifies, except that in lieu of the requirements of Section 1.7.2-Design, breakaway supports to carry loads as Section 2 provides and to cause a change in vehicular momentum no greater than 1,100 pound-seconds (500 kg-seconds) when impacted by a 2,250 pound (1,000 kg) vehicle traveling at any speed within a range of 20 to 60 miles (30 to 100 km) per hour.

Permanently mark aluminum transformer bases for exterior identification. Fabricate doors so that they will fit flush with the face of the base, and attach permanently by means of a top-mounted, continuous, stainless steel hinge. Latch doors by means of a tamperproof, quarter-turn latch.

Construct base as a breakaway base using permanent mold casting per ASTM B108. Heat-treat base to 356-T55 to meet Federal Highway Administration requirements. Furnish four heavy-duty hex head bolts and nuts conforming to ASTM A307 and galvanized in accordance with ASTM A153.

Paint the bottom of the steel pole anchor base and the top of the aluminum transformer base with a heavy film of zinc-rich paint (Federal Spec. TT-P-64, Type II) where mounting steel poles on aluminum bases.

I. Accessories. Include a handhole near the base of each pole oriented as shown. Weld a steel reinforcing frame to each handhole fit with a cover plate fastened by stainless steel screws. Provide a grounding lug opposite handhole on inside wall of pole as shown on the details. Include a wire support J-hook welded near the top and a removable pole cap for each pole. Design poles and arms so their interiors may be used for concealed wiring. Include grommeted wire outlets for signal heads in each mast arm. Furnish hanger clamps with clevises on the mast arms for the signal heads and signs as required. Include a removable end cap for each mast arm.

Provide a handhole located opposite the mast arm flange with an additional J-hook located a short distance above for signal poles combining provisions for roadway lighting. Include bracket arm pole plates.

Furnish pedestrian pushbutton access holes and blind half-couplings for cable, pedestrian signal heads, etc., as plans require.

J. Welding. Make all welds continuous weld as Item 732 requires. Develop full strength of pole by all structural welds. Welds attaching modifications (all others are structural) shall be sufficient to carry the load with a good factor of safety. The welding process shall not reduce the strength of the pole adjacent to welds.

K. Galvanizing. Hot dip galvanize all parts, inside and outside, of all steel components, fittings and fasteners after performing cutting, welding, drilling, boring, etc. Clean threads after galvanizing. Galvanize in accordance with the following ASTM Designation Nos.:

1. Poles, Seamless Steel Pipe- --- A123
2. Iron and Steel Hardware and Fasteners- --- A153
3. Bracket Arms- --- A53

L. Installation. Cure new concrete anchor base foundations for at least seven days before setting anchor base poles. Rake steel poles as details specify for the pole size against the resultant strain produced by the proposed messenger cables, mast arm and/or bracket arm.

Do not load steel anchor base or embed base poles by attaching messenger cables and/or mast arm until all the concrete cures for a period of at least 14 days.

Use lesser times for installing and loading of poles in accordance with 511.17, if beam test specimens exceed strength requirements.

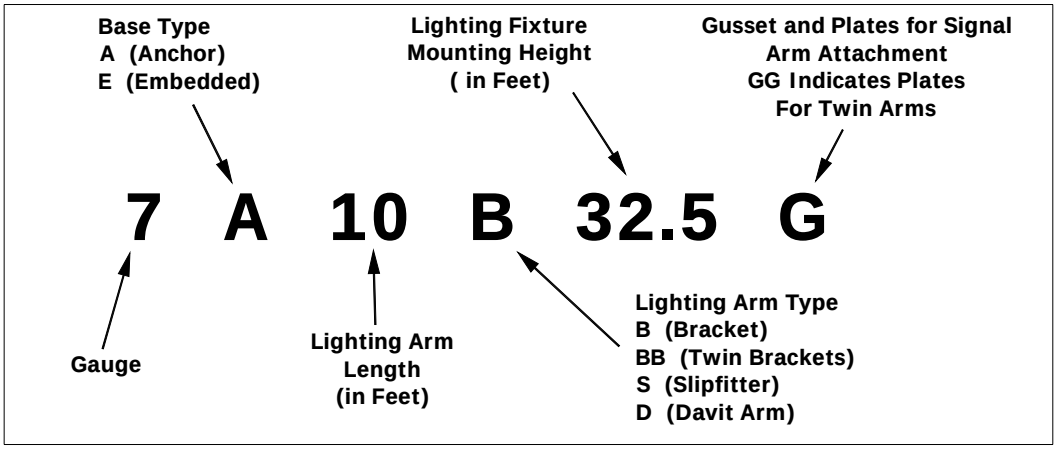
After attaching all proposed equipment and materials, which will be supported by an anchor base pole, adjust the leveling nuts so that the center of the top of the pole is directly above the center of its base.

Inspect galvanized poles for defects in galvanized surfaces after erection. Spot prime minor defects or scratches and paint the entire pole in accordance with Item 1317.

Remove burrs, projections and sharp edges, which could damage cable from cable entrances and raceways in the poles and arms.

M. City Pole Design Number and Definitions. See Table 1318.01 for chart of City pole design number showing guage, base type, lighting arm length, lighting arm type, lighting fixture mounting height and gusset plates for signal arm attachment.

Table 1318.01 – City Pole Design Number Key



1. For signal strain poles: First two digits indicate transverse load in hundreds of pounds. The last three digits indicate deflection in inches per hundred pounds. Refer to Standard Drawing ES-1.

2. For lighting, combination lighting and signal arm poles, refer to Standard Drawing ES-3B.

Permanently attach City pole design numbers to the bottom of the pole on a metal tag.

1318.02 Pedestals. Fabricate pedestals for the support of traffic control and/or Island Lighting equipment of nominal three or four inch (75 or 100 mm) diameter seamless schedule 40 steel pipe and length as Contract specifies, with parts hot dipped galvanized in accordance with ASTM A123. Design pedestals to mount on an anchor bolt foundation as plans show.

Thread pedestals into an anchor base prior to mounting. Spot prime the threaded portions of the pedestal and base with soya-alkyd primer with at least 60 percent pigment by weight being zinc dust, "Zinc It" (cold galvanizing coating) by CRC Chemical Company, or approved equal, prior to assembly.

Provide all pedestals with an approved grounding lug, field drilled and fastened to the inside of the pedestal as details show. Provide all pedestals not requiring a post top attachment with a galvanized pedestal cap. Each pedestal shall include the furnishing of anchor bolts.

Specify pedestal diameter. Normally, use three inch (75 mm) diameter pedestals for pedestrian pushbutton posts.

1318.03 Guy Supported Mast Arm with Accessories. Furnish and install mast arms of the length specified to support signals, signs and detectors as plans and details show.

Construct arms of two inch (50 mm) galvanized steel schedule 40 pipe and fasten to the signal pole with spreader arms, guy rods, pole clamps and/or plates, guy support hardware and all fittings as details show.

1318.04 Wood Poles. All wood poles to be from Southern Yellow Pine and meet the requirements of ANSI Standard 05.1 "Specifications and Dimensions for Wood Poles" except as modified herein.

A. Treatment. Season poles and pressure treat in accordance with AWPA Standards C1 and C4 using the full cell process and with any exceptions indicated herein.

B. Conditioning. Accelerate air season (AAS) poles to an average moisture content of 25 percent at 2-1/2 inch (60 mm) depth.

C. Preservative and Results of Treatment. Table 1318.04 lists approved preservatives and the process and results of treatment to meet the requirements in Table 1318.04.

Table 1318.04 – Approved Preservatives, Processes and Results for Treatment

			Results of Treatment		
Preservative Code Description	**APWA Preservative Standard**	**APWA Standard for Analysis of Preservative**	**Minimum Penetration (% of Sapwood)**	**Minimum Retention lb per ft^3 (kg per m^3)**	**Method of Determination**
SK Chromated Copper					
Arsenate CCA Type C	P5	A2	90	0.60 (10)	By Assay

E. Determination of Penetration. Determine penetration in accordance with AWPA Standard C4 - Group "B" Poles.

F. Re-Treatment. Contractor may retreat poles failing to meet the minimum requirements of either penetration or retention in accordance with AWPA Standard C1, Paragraph 6 - Re-treatment, with the exception that Contractor must restrict retreatment to one time for any pole.

G. Re-Drying. Re-dry poles treated with a water-borne preservative to an average moisture content not to exceed 27 percent at 2-1/2 inch (64 mm) depth following the full cell pressure-treatment.

H. Marking. Mark poles by burn-branded legibly and permanently on the face and on the butt.

I. Ground Wire. Provide poles with a 1/4 inch (6 mm) brass or No. 2 bare copper solid ground wire. Secure ground wire to the pole with copper staples as plans show. Extend the ground wire the entire length of the pole above grade with at least three feet (914 mm) of slack for connection to a ground rod.

Protect the ground wire up to a minimum of eight feet (2.5 m) above grade as follows:

1. Milling or sawing a 1/4" x 1/4" (6 mm x 6 mm) slot in the face of the pole and inserting and securing the ground wire, or

2. Covering the ground wire with a wood tree molding. Construct molding of seasoned wood or highest grade fir and provide two coats of hot linseed oil prior to installation. Secure the molding to the pole with copper staples.

J. Inspection. The Engineer may inspect all poles at his or her discretion. Poles not meeting the minimum requirements of this specification will be rejected and disposed of at Contractor's cost. Notify the Engineer when poles are ready for shipment to the site so that the Engineer may schedule an inspection.

K. Installation. Excavate for wood poles by auger or hand labor and to the dimensions shown on the details for the pole size specified.

Place a brick or concrete block in the excavated hole prior to insertion of the pole to prevent settlement of the pole.

Construct concrete collars of Class C concrete.

Use excavated material as backfill.

Rake poles installed in the excavated foundation as details show. Cure concrete collars for at least three days prior to loading by the attaching of messenger wire and/or mast arms.

Where plans specify strut guys with the pole, use additional concrete, anchor rod and accessories.

Where plans specify poles to be installed in paved areas, provide a 1/2 inch (13 mm) expansion collar.

1318.05 Pole Guys.

A. General. Furnish and install pole guys by type as shown on the plans and details and as herein specified.

B. Guy Wire. Construct the guy wire of a minimum 5/16 inch (8 mm) (7 No. 10 AWG) copper covered steel messenger wire per ASTM A-460.

C. Strut Guy. Construct anchor rods of steel with thimble eye and guy rod washer and with an ultimate strength of 16,000 lbs. (72,000N) (minimum). Support the guy wire from the pole with two each steel pole struts as shown on the details.

D. Down and Sidewalk Guy. A thimble eyed steel anchor rod with a steel helix screw or deadman anchor.

1. Helix Screw. Construct of six inch (150 mm) diameter (ultimate strength including rod, 23,000 lbs. (100,000 N) minimum).

2. Deadman Provide a minimum four feet (1.2 m) long wood stub post ten to 15 inches, (250 to 380 mm) in diameter. Treat the post and meet the requirements of Item 1318.04 "Wood Poles". Use anchor rod with deadman to bear 16,000 lbs. (72,000 N) ultimate strength (minimum).

Provide a guy wire with an eight foot (2.5 m) No. 18 gauge steel guy guard at grade.

Where plans specify a sidewalk guy, provide an additional two inch (50 mm) schedule 40 steel pipe to suspend the guy from the pole to provide adequate clearance for pedestrian use of the sidewalk.

E. Hardware. Secure guy wires with a three bolt steel suspension clamps rated for 25,000 lb. (120,000 N) cable strain for 1/4 to 3/8 inch (6 to 10 mm) guy wires using 1/2 inch (13 mm) high strength track bolts and served into a five to seven inch (130 to 180 mm) mause. Provide all thimble eyes, through bolts, lag screws, pole plates, fittings, nuts and bolts as details show.

Hot dip galvanize all hardware, anchor rods and screws, struts, guy guards and pipe in accordance with ASTM Specification A-153 and A-53 for pipe.

F. Installation. Install the pole guy prior to the installation of signal equipment on the span and/or mast arm attached to the pole.

Install the anchor by power or hand auguring. Thoroughly tamp loose soil produced by the auguring to maintain maximum tension in the guy.

After installation, tighten the guy wire such that the resulting deflection of the pole due to signal load is corrected and the pole is plumb.

1318.06 Cable Support Assembly. Where plans specify, furnish and install a cable support assembly. Use the cable support assembly with each cable or cable group entering the interior of steel poles by weatherhead or mast arm. Assemble using a cable grip and, when plans require, a length of messenger wire forming a sling including thimbles and split bolt clamps. The support eliminates cable strain at the pole inlet by placement over the J-hook provided within the pole.

Make the cable grip from the proper size and strength for the cable or cable group of the flexible "closed" or "split with rod" type, of stainless steel or tin coated bronze, and equip it with a single "U" eye bale. Construct the smallest cable grip to have a minimum rated breaking strength of 250 pounds (1,000 N).

Make slings for cable supports from three-strand 0.165-inch (4 mm) diameter copper clad or galvanized twisted steel wire with length as plans require. Use groove thimbles to form eyes at each end of the sling to match the wire. Adjust the sling to the proper length with the wire at each thimble and lap and secure with No. 6 split bolt clamps.

1318.07 Method of Measurement. Measure holes, complete with mast and/or bracket arms and pedestals as a complete unit in place including furnishing anchor bolts, which are installed as part of the foundation, and raking and painting.

Measure guy supported mast arms as a unit by length, and erect in place including clamps, guy rods, spreader arms, fittings and hardware.

Measure wood poles as a unit in place including the excavation, concrete, backfilling, raking, ground wire installed, moulding, expansion collar and removing waste and incidentals.

Measure pole guys as a unit by type assembled and installed complete with all hardware and accessories.

Measure cable support assemblies as complete units in place and accepted, including grips, sling wires, thimbles and clamps.

1318.08 Basis of Payment. City will make payment at the Contract unit price bid for each item as the Contract specifies and be full compensation for all labor, materials, tools, equipment and incidentals necessary for each item furnished complete, in place, and accepted.

Item	Unit	Description
1318	Each	Signal strain pole,___ gauge,____inches(base) by___feet (length), City Code No.____
1318	Each	Signal arm pole, ____ gauge, ____ inches (base) x ____ feet (length), with mast arm(s) ____ gauge, ____inches (base) x ____ feet (length), Design No. ____.
1318	Each	Each Lighting pole, ____ gauge, ____ inches (base) x ____ feet (length) with ____ foot bracket arm, Design No. ____.
1318	Each	Pedestal, ____ inches (diameter) x ____ feet (length).
1318	Each	Guy supported mast arm, ____ feet (length) with accessories.
1318	Each	Wood poles, class ____ foot (length).
1318	Each	Pole guy, ____ type.
1318	Each	Cable support assembly.

Item 1319 Foundations

1319.01 Concrete Foundations.

A. Location. Locate and stake foundations for poles, pedestals and ground mount cabinets at the proper survey station, or dimension reference, and with the proper elevation in accordance with the plans. Where plans provide no locations or dimensions, the City will provide staking.

Check for underground or overhead obstructions during staking and if encountered the Engineer may change the foundation location. After staking, notify the Engineer at least three days before scheduled work so the Engineer may field check the foundation locations for approval. After approval, be responsible for setting the correct location, elevation, attitude (either vertical or with rake) and horizontal orientation for all poles, pedestals and cabinet bases used with the foundations.

B. Excavation. During excavation, keep adequate walking areas for pedestrians clear of equipment, materials, supplies and excavated materials at all times. Move any excavated material obstructing any portion of the sidewalk or street area at the end of the working day so as not to obstruct the sidewalk or street area. Adequately barricade and red light excavated material off of, but not adjacent to the sidewalk area. Neatly restore sidewalks, driveways, and

sodded areas to the satisfaction of the City. Restoration is incidental to the payment of this item and in conformance with Item 1334.

Use an earth auger to excavate; however, in areas of underground utilities, excavate by hand labor. At a depth greater than 12 inches (300 mm) below the ground line, place unformed concrete only if the soil on the sides and bottom of the excavation is undisturbed. When encountering soil that tends to cave and form an irregular shape, construct the foundation either by placing additional concrete to fill the excavation, or by constructing a modified pole foundation the Engineer approves. Supply shoring, bracing, and other materials necessary to safely support the sides of the excavation, protecting existing roadway surface, sidewalk and all other existing items adjacent to this work.

C. Existing Conditions. Plans show foundation details for average soil conditions. If, upon inspection of the excavation, solid rock or poor soil conditions are found such as silty clay or wet silt, the City may review the depth and/or width of the foundation to be installed. Pay for the additional work and materials needed for increased depth and width at the unit price per cubic yard (m^3) for this item.

Stop work and notify the City and the owner of the utility if the Contractor uncovers an existing water main, gas main, sewer pipe or underground conduit while making an excavation for a pole foundation. Payment for the additional work resulting in necessary relocation of the foundation, including filling the original foundation excavation and re-excavating in a new location designated by the City at the unit price per cubic yard (m^3) for this item.

D. Placement of Reinforcing and Anchor Bolts. Provide the required reinforcing rods, anchor bolts, and conduit ells in the arrangement as shown on the plans and details in the foundations for anchor base type poles and pedestals. Free all reinforcing steel and anchor bolts of injurious rust.

Accurately place reinforcing steel and anchor bolts and adequately support by concrete, metal, or other approved chairs, spacers, or ties, and secure against displacement. Make no splices of reinforcement except as shown on the details. Have at least three inches (76 mm) of concrete between reinforcements and the ground contact surface.

Deform reinforcing bars and plain billet steel bars for concrete reinforcing. Meet the requirements of Item 709.01. Assemble reinforcing rods into cages by either wire tying or tack welding. Use forms for the foundation upper square portion. Contractor may use templates to accurately hold anchor bolts until concrete sets. After pole or pedestal erection, use concrete grouting in the space between the metal base and the foundation surface.

E. Inspection. Notify the City in advance as to when the excavation will be completed to the full depth as plans and details require. Place **no concrete until the City inspects the excavation complete with the reinforcing steel cage, anchor bolts and conduit ells in place.**

F. Placement of Concrete. Provide preformed elastic joint sealer conforming to Item 705.11 between all foundations and abutting paved areas. Use 499 Class C Concrete and conform to the requirements of 511. While placing concrete, do not allow concrete to come in

contact with the sides of the excavation in such a manner to cause soil to mix with the concrete. Thoroughly consolidate by suitable means during placement all concrete, and work around the reinforcement and embedded fixtures and into the corners of the forms. Protect the anchor bolt threads against damage during concrete placement.

G. Backfill. Contractor may remove forms 24 hours after placing concrete. Remove all forms before backfilling. Use excavated material as backfill. Place backfill in layers and tamp to prevent future settlement of backfill materials. Dispose of the excavated material not needed or backfilled.

Set concrete around foundations for embedded type strain poles with the pole braced in the required attitude (rake) until the concrete sets. Remove bracing after several days.

H. Other Structures. Include foundations for poles and pedestals mounted on bridge structures and walls in the structure and/or wall item. Coordinate the installation of anchor bolts with the structure construction. Contractor may use U-type anchor bolts in lieu of standard anchor bolts.

1319.02 Ground Mount Cabinet Base Breakaway Extension. This work shall consist of furnishing and installing a breakaway extension for the specified controller or cabinet foundation, which includes cinder brick walls, galvanized extension anchor bolts with coupling, and finishing the walls with sand-cement grout in accordance with the details.

1319.03 Staking. Unless otherwise indicated, provide staking where no locations or staking are dimensioned. Stake in accordance with Item 623. Payment for staking is incidental to the payment of each item for which the stake is provided.

1319.04 Method of Measurement. Foundation concrete is the number of cubic yards (m^3) as determined by calculations from plan dimensions, in place, complete and accepted, and shall include excavation, reinforcing steel, conduits, concrete, backfilling, and disposal of surplus excavation.

Measure breakaway extension for ground mount cabinet bases as a unit in place and include all extension bolt hardware, cinder brick grouting and finishing.

1319.05 Basis of Payment. Make payment at the Contract price bid per cubic yard (m^3) or per unit price bid for the concrete foundation as plans specify, and a per unit price bid for a breakaway extension for ground mount cabinet foundations. The City considers this full compensation for all labor, materials, tools, equipment and incidentals necessary for each item furnished complete in place and accepted.

Item	Unit	Description
1319	Cubic yard (m^3)	Concrete for or each anchor base foundations.
1319	Cubic yard (m^3)	Concrete for or each embedded pole foundations.

1319	Each	Ground mount cabinet foundation breakaway extension.

Item 1320 Grounding Equipment

1320.01 Equipment Grounding. Connect all equipment ground wiring and hardware in accordance with the plans and details. Ground all non-current carrying metal parts, poles, pedestals, cabinets, conduit and equipment. Payment for providing and installing the grounding material is incidental to the item grounded, except where installing an equipment ground wire with the ungrounded wiring for circuits. In such cases a pay item will be specified.

1320.02 Ground Rods. Install Ground rods and associated cables in conformance with 625.16. Use copper clad (bonded copper to steel) high strength steel, one inch by 10 foot (25 mm diameter by 3 m) ground rods. Use minimum No. 4 AWG insulated with 600 Volt Class ground cable, Type RHH/RHW/USE or UF insulation. Connect ground wire from the pole, pedestal or enclosure to the top of the ground rod by exothermic weld or approved one inch (25 mm) ground rod clamp.

Drive ground rod the entire length, with at least one foot (305 mm) of cover, in undisturbed earth and at least one foot (305 mm) from the foundation, unless plans specify otherwise.

1320.03 Structure Grounding. Furnish and install a complete grounding system where plans specify in the plans and in accordance with Item 625.16 and the details.

Use ground rods to conform to Item 1320.02.

1320.04 Method of Measurement. Measure ground rods using as the actual number of ten foot (3 m) lengths and include the cable welded to the ground rod(s) and connections. Measure structural grounding as a unit including all ground rods, cable and connections as plans and details show.

1320.05 Testing of Ground Rods. Resistance tests and document each ground rod per Item 625.19.B.

1320.06 Basis of Payment. City will make payment at the Contract unit price bid for each item installed complete, connected, tested and accepted and constituting full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1320	Each	Ground rod
1320	Each	Structural grounding

Item 1321 Conduit, Risers and Trenching

1321.01 Trench, by Depth. Provide trenching where specified in accordance with Item 625.13 and of the depth herein specified.

1321.02 Trench, Paved Areas, by Type. In addition to the provisions of Item 625.13, trench paved areas as details show. Premarked sawcut lines shall follow existing joints or grooves where possible, and Engineer approves before Contractor sawing. Restore in accordance with Item 603.10 with backfilling, surface restoration to previous condition and disposal of surplus material.

1321.03 Drain Trench. Excavate to a width and depth sufficient to allow proper connection of drain conduit to proposed sewer connection. Meet the applicable backfilling requirements of Item 603 and Item 625.

1321.04 Conduit. Use conduit of the type and size as specified on the plans. Install the materials furnished and used in this work in accordance with the details and the requirements of Section 625.12. Install all conduit pitched to drain toward the pullboxes which have drain connections to a storm sewer, and include all elbows, fitting and connections. The pull cable shall be 3/8 inch (10 mm) minimum braided nylon or polypropylene twist rope rated for 2,500 pounds (10,000 N) breaking load and 250 pounds (1,000 N) working load. Install pull cable in all conduit which will not have circuit wiring or cabling installed during construction.

Use rigid metal conduit of galvanized steel or heavy-wall threaded aluminum and in accordance with Item 725.04.

Use PVC conduit meeting the requirements of Item 725.05 except for the following types:

Type I Schedule 40 - use with Class C concrete encasement where specified.

Type DB is not accepted.

Type EB is not accepted.

Type II (heavy wall) - schedule 40 min. use for direct burial or on wood poles as specified.

Use drain conduit to sewer lines of cast iron pipe, including elbows and fittings, and meeting the requirements of ASTM A-74.

1321.05 Conduit, Jacked Under Pavement. The work of this item includes furnishing and installing rigid metal conduit meeting the requirements of Item 1321.04, including drilling under paved or sodded areas or other areas designated by the Engineer. The requirements of section 625.14 apply to this item of work as well.

Place conduit under existing pavement or paved shoulder, furnished and installed by jacking or horizontal drilling in accordance with the details, and with the Engineer's approval. When using the drilling method, the bore shall not exceed the conduit outside diameter by more than five percent. Install conduit with the least amount of disturbance to existing facilities with all operations maintained within the right-of-way. Backfill push pits or other necessary excavations and restore surfaces in accordance with Item 603.10.

1321.06 Weatherhead and Conduit Riser. The weatherhead and conduit riser provides a wiring raceway for signal, power and/or lighting cable from a traffic control cabinet, safety switch, lighting controller, pedestrian signal, push button or others as plans specify to the overhead span wire, termination point for service connection and/or an underground pullbox or foundation.

The weatherhead shall be Schedule 40 PVC. Use galvanized steel (per 713.04) or heavy-wall threaded aluminum conduit per Item 1321.04 and PVC Type II per Item 1321.04.

Use galvanized steel or heavy wall aluminum conduit from the ground line up to eight feet (2.5 m) height on the pole. Use Type II PVC for ll conduit above eight feet (2.5 m).

Drill 3/8 inch (10 mm) drain (weep holes) at all low elevation points in the conduits at elbows as details show. Use conduit clamps of galvanized steel or malleable iron for wood poles and stainless steel banding 1/32 x 3/4 inch (1 mm x 20 mm) for steel poles.

Space clamps or bands five feet (1.5 m) on centers from eight feet (2.5 m) and above grade and 30 inches (750 mm) on center on all conduit below eight feet (2.5 m) above grade.

Provide grounding bushings of OZ No. 2004, M & W GB-550 or approved equal to ground steel conduit where plans specify. Contractor may install PVC conduit directly into the top of a street lighting controller and safety switch, in which case grounding bushings may not be required. Make connections into the top of any enclosure with approved watertight fittings.

1321.07 Conduit Markers. Provide a conduit marker of non-corrosive material as details show and where conduit is specified and installed dead ended beneath grade. City shall make payment incidental to the item of conduit installed.

Where plans specify or as the Engineer directs, furnish and install precast or cast-in-place concrete markers as details indicate, and construct in accordance with the applicable requirements of Item 511.

1321.08 Utility Crossover. Provide joint utility conduit as shown in the Subdivision Manual. Install four wide by two high, four-inch PVC schedule 40 conduits, concrete encased unless noted otherwise on the plans. Do not continue concrete encasement to the end of the conduit.

1321.09 Method of Measurement. Measure trenching as the number of feet (meters) of trench from center to center of foundations, pullboxes, etc., and include all excavation, backfill, compaction, disposal of surplus material and restoration of disturbed facilities and surfaces.

Measure conduit as the number of feet (meters) of conduit furnished and installed from center to center of pullboxes, foundations, etc., and include all fittings, appurtenances, joints, bends, grounds and concrete encasement where plans specify. Where plans call for jacking, conduit and jacking shall be one pay item.

Measure horizontal boring or jacking conduit as feet (meters) of boring from center of foundations, pullboxes, etc., and include all fittings, appurtenances, joints, bends, grounds, and concrete encasement where plans specify.

Measure weatherhead and conduit riser as a complete unit, in place, by conduit diameter including all fittings, clamps, banding, bushings and weep holes.

Measure conduit markers as a complete unit precast and/or cast in place.

Measure utility crossover as the number of feet of furnished and installed conduit grouping measured from end of crossover to end of crossover, including all appurtenances, joints, caps, and concrete encasement. Do not measure individual conduits.

1321.10 Basis of Payment. City will make payment at the Contract unit price bid for each of the items as Contract specifies, furnished complete and in place, and including all labor, material, tools, equipment and incidentals necessary.

Item	Unit	Description
1321	foot (meter)	Trench, _____ inches (mm) deep.
1321	foot (meter)	Conduit, jacked or drilled under (specify sod or pavement) ____ inches (mm) (nominal diameter).
1321	foot (meter)	Trench, paved areas, less/more than 6" (150 mm)
1321	foot (meter)	Drain trench
1321	foot (meter)	Conduit, ____ inches (mm) (diameter) (specify type) ____ (specify concrete encasement or jacked under pavement where required).
1321	Each	Weatherhead and conduit riser,_____ inch (mm) _____ (diameter)

1321	Each	Conduit marker
1321	foot (meter)	Utility Crossover

Item 1322 Electrical Boxes

1322.01 Concrete Pullboxes. Construct pullboxes by size and type as plans specify and as details show. Excavate as nearly as practicable to the outside dimensions of the pullboxes. After setting pullboxes to proper grades, backfill excavated spaces around pullboxes with suitable material and tamp in thin layers.

Install pullboxes cast-in-place using Class C concrete with the frame cast integral with the pullbox. Cast end bells and couplings for conduit entrances with the pullbox or block out a section of each of the walls prior to the casting, then grout the end bells and couplings into place. Provide reinforcing steel in all pullboxes installed in streets and driveways. Where plans specify drainage, provide the pullbox with a concrete floor, a three-inch (75 mm) drain conduit, a cast iron strainer, and a 1/2-inch (12 mm) preformed joint sealer conforming to Section 705.11 between all pullboxes and abutting paved areas. Grout and finish all openings and spaces to the satisfaction of the Engineer. For all pullboxes in sidewalks or street areas, cast frame and lid integral with final sidewalk or paving. City will not permit precast pullboxes with integral frames and lids in these areas.

Install cast iron frames meeting the requirements of ASTM Specification A-48 Class 30 for regular duty pullboxes and ductile iron meeting the requirements of ASTM Specification A-536 Grade 60-40-18 for street duty pullboxes. Furnish frames and covers of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, warps, or other injurious defects.

The Contractor may furnish precast pullboxes as an alternate, constructed of reinforced Class C concrete and meeting as a minimum all dimensions and requirements for cast-in-place pullboxes. Provide pullboxes with walls wide enough to recess the frame into the casting. Grout spaces between the casting and frame to secure the frame to the casting.

1322.02 Downtown Special Pullboxes, 22 inches x 22 inches (554 mm x 554 mm). In Addition to the requirements of Item 1322, furnish and install all Downtown Special (Non-Roadway) 22 inch by 22 inch pullboxes with covers meeting the following specifications:

Provide pullbox covers with dimensions that conform to those shown in Drawing A. Construct pullbox covers of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Construct the cover monolithically to limit stress cracks due to differing coefficients of thermal expansion. Use only matched metal tooling to manufacture the product to assure consistent production from part to part. Provide covers with the following dimensions: 21-13/16 inch by 21-13/16 inch, with a 15/16 inch bearing ledge (554 mm x 554 mm x 24 mm). Provide covers with dimensional tolerances of $\pm$ 1/16 inch (1.6 mm) except overall length and width dimensional tolerances ($\pm$ 1/8 inch [3.2 mm]). Provide covers that weigh 60 pounds (27 kg) ± 10 percent. Provide covers with bottoms that allow flush mounting on a flat surface to

prevent entry of foreign objects. Provide covers with the following minimum allowable properties:

A. Load Testing. Distribute vertical load over a 10 inch by 10 inch (254 mm x 254 mm) area. Apply load with a 10 inch by 10 inch x 1 inch (254 mm x 254 mm x 25 mm) thick steel plate backed with a ¼ inch (6 mm) thick rubber shim. Use a spherical bearing swivel head in the testing machine. Center the loading pad over the portion of the cover which will produce the maximum deflection under load. Take deflection measurements perpendicular to the cover and wherever maximum deflection occurs. Position deflection measurement device or devices so as to measure only the deflection of the cover.

Support the cover along the total length of all four sides. Use a supporting surface with a maximum width of one inch (25 mm). The Loading Diagram is shown on Drawing B.

The design load for the cover is 8,000 pounds (3,630 kg). The cover must pass a static load test of 12,000 pounds (5,450 kg) which represents the design load multiplied by a factor of safety of 1.5 The cover must sustain a 8,000 pound (3,630 kg) pound load with no more than 1/2 inch (13 mm) deflection.

B. Chemical Resistance. Test according to ASTM D-543, Section 7, Procedure 1 using the following chemicals in the concentrations noted:

1. Sodium Chloride 5%
2. Sodium Carbonate .....0.1 N
3. Hydrochloric Acid.....0.2 N
4. Acetic Acid 5%
5. Transformer Oil .....Per ASTM D-543
6. Sulfuric Acid.....0.1 N
7. Sodium Sulfate.....0.1 N
8. Sodium Hydroxide .....0.1 N
9. Kerosene .....Per ASTM D-543

C. Flexural Strength. Test in accordance with ASTM D-790.

D. Accelerated Service. Test in accordance with Procedure E, ASTM D-756.

E. Water Absorption. Test in accordance with ASTM D-570, Section 5, 6.1 and 6.5.

F. Impact Resistance. Provide covers that can withstand a 70 foot-pound (95 N-m) impact at any point on the cover administered with a 12 pound (5.5 kg) weight having a "C" TUP (ASTM D-2444) without puncturing or splitting. Perform the test with the cover resting on a flat, rigid surface such as concrete or a one inch (25 mm) steel plate.

G. Skid Resistance. Provide skid resistant covers with a minimum 0.50 coefficient of friction molded on the top surface of the cover. Coatings are not acceptable.

H. Flammability Test. Test in accordance with ASTM D-635.

I. Ultraviolet Exposure. Test in accordance with ASTM G-53 using an U.V.A. 340 bulb.

J. Material Retention. Except for the Flammability Test, the minimum acceptance criteria for material is 75 percent of the control specimen values. For Load and Deflections, no more than two percent change in weight or any dimension, no visual cracking, crazing, checking, blistering, or surface pitting. For the Flammability Test, the buring rate must be less than 0.3 inches in length for each 0.1 inch of thickness (0.3 mm for each 0.1 mm)

K. Temperature Range. Design the cover to be suitable for installation and use through a temperature range of –40° F to +140° F (-40° C to +60° C).

Assume responsibility for proof of compliance with the latest version of the ASTM standards. Attach MSDS in weather-tight vessel to each order. Provide and submit to the Engineer prior to shipment of materials certified test reports signed and stamped by a Professional Engineer registered in the State of Ohio. Provide covers that are Quazite, CDR Systems or approved equal.

Provide covers that are _____ in color. Provide covers with pick holes along the middle of one side.

Submit one sample of the cover proposed for use to the Engineer for approval prior to ordering.

1322.03 Junction Boxes. Specifications include: fabricated of hot dipped galvanized steel in accordance with ASTM A-123, raintight, and UL approved and installed as details show. The work of this item includes all approved mounting hardware of a non-corrosive material. Where embedding junction boxes in concrete structures, provide the boxes with drains.

1322.04 Sectionalizers. Install sectionalizers consisting of terminal strips and cabinet for mounting on poles in the vicinity of the interconnecting cable line. Install and mount hardware according to plan details.

Provide sectionalizer with barrier-type terminal strips rated for a minimum of 600 volts insulation. Furnish terminal poles rated for a minimum of 30 amps of the tubular screw type with pressure plate sized from 1 to 3 No. 12 AWG wires. Install terminal strips with twelve poles. Install the type and number of strips plan details require.

Furnish terminal strips with frames of bakelite, nylon or approved high-quality insulating material.

As an alternate, the sectionalizer terminal strips may consist of poles provided with sliding or movable links, for opening and closing circuits without disturbing any connected wiring, and designed to prevent accidental contact with adjacent poles when opened. Install nuts, bolts, links, lugs and washers of silicon bronze metal, nickel-plated, stainless steel or approved equal. Install insulating posts, barriers and terminal frames of bakelite, nylon or approved high quality insulating material rated for 600 volts (minimum). Provide bolts that are cast with the terminal frame molding for a most rigid pole.

Mount the terminal strips in the cabinet on stand-offs as details show.

Install weatherproof and raintight cabinets meeting the requirements of NEMA Type 3R and equipped with approved wing type, butterfly link lock or luggage type stainless steel latches.

All wiring connections at the sectionalizer must conform to the requirements of Item.

A type I sectionalizer is 14 inches high by 8-1/4 inches wide by four inches deep (356 mm x 210 mm x 102mm). It has two quick release door latches and houses a 24 terminal barrier strip. Provide type I sectionalizers on overhead routes where the cable specified is six or 12 pair. A type II sectionalizer is 24 inches high by 8-1/4 inches wide by four inches deep (610 mm x 210 mm x 102 mm). It has three quick release door latches and houses a 50 terminal barrier strip. Provide type II sectionalizers on overhead routes where the cable specified is 25 pair.

1322.05 Method of Measurement. Measure pullboxes as a complete unit, in place, including excavation, forms, concrete class C, frame and cover, reinforcing steel, grouting fittings, strainer/cesspool, aggregate, 1/2 inch (13 mm) expansion joint, backfilling and restoration of the immediate area.

Measure junction boxes as a complete unit, in place, including all mounting hardware, anchors and drains.

Measure sectionalizers as a complete unit, in place, including cabinet, terminal strips, lugs, connections, mounting hardware, reversible clamps and testing.

1322.06 Basis of Payment. The City will make payment at the Contract unit price bid for each item furnished and installed complete and accepted, including all labor, materials, tools, equipment, and incidentals.

Item	Unit	Description
1322	Each	Pullbox, concrete, ____ inches (mm) x ____ inches (mm), type
1322	Each	Junction box, ____ inches (mm) x ____ inches (mm) x ____ inches (mm)
1322	Each	Sectionalizers, ____ type

Item 1323 Cables, Connectors, and Accessories

1323.01 Cable, By Type and Size. Install and route cable and wire by size and type as plans and details specify. Furnish cable and wire with the specified number and size of conductors, the required insulation voltage rating and cable service type specification.

Mark all cable and wire jackets indelibly every five feet (1.5 m) showing the Manufacturer's name, wire size, voltage rating, and type and style.

Where plans and specifications designate cable outer jacket coloring, furnish cable manufactured with an outer jacket of the color specified.

Furnish all cable and wire rated at 600 volts except CTCS Cable with conductors of solid copper unless plans specify otherwise. Cable by type to meet the following requirements:

A. Service Cable. Install serial self-supporting cable with an aluminum clad steel support wire as electrical neutral (duplex or triplex) or two conductor or two each one-conductor power supported with a 1/4 inch (6 mm) messenger cable per Item 1323.02. Duplex or triplex cable to be neoprene or cross-linked, polyethylene insulated conductor(s) (one for duplex, two for triplex), cabled around a bare seven-strand ACSR neutral messenger of the same AWG size as the insulated conductor(s) except that the ASCR messenger shall be no smaller than No. 4 AWG.

B. Service Cable (duplex or triplex as specified). Install aerially from a remote power source to the structure or pole housing, street lighting controller or disconnect switch. Use a No. 6 SE2 with ground to complete the connection between the disconnect switch and the traffic signal controller.

C. Power Cable. Furnish two single stranded copper conductors or a two-conductor cable and install from the local source to the disconnect or controller enclosure. Install cable type RHH/RHW/USE insulated with sufficient excess cable to allow Cincinnati Gas and Electric Company crews to connect to their secondary or service point.

Where plans specify traffic signal controllers, route power cable in a separate 1 inch (25 mm) conduit from the controller cabinet to the service connection.

D. Feeder and Pole and Bracket Cable. Install RHH/RHW/USE insulated. Permanently mark or identify Equipment ground conductors with a green color insulation or with green markings in accordance with the National Electric Code.

E. Series Street Lighting Cable. Install No. 8 AWG, solid copper, single conductor, rated 5000 volts, 60 hertz, A.C., rubber insulated, neoprene jacketed for direct burial service. Minimum insulation thickness is 10/64 inch (4 mm) and minimum neoprene jacket thickness is 4/64 inch (1.5 mm).

F. Traffic Signal Cable. Install cable meeting the requirements of IMSA Specification 19-1 or 20-1 with Solid or Stranded Copper conductors. Install Signal cable between signal heads and controller cabinets and install interconnect cable between controller cabinets of different intersections, as plans show. Furnish signal and interconnect cable suitable for aerial installation, supported by messenger wire or for routing within underground conduit. Furnish electrically shielded interconnect cable when plans specify for installations where performing multiplexing or where transient electrical impulses could be detrimental. Install shield type interconnect cable meeting the requirements of IMSA 19-2 or 20-2.

G. Electrical Cable for electrical signs and island lighting. Install two conductor, type RHH/RHW/USE or UF insulation. The City may accept cable furnished with insulation meeting ISMA 19-1 or 20-1.

H. CTCS Cable - Computerized Traffic Control System Cable. Install twisted pair, shielded communications cable #19 AWG or #24 AWG, unless plans specify otherwise.

Install cable meeting the Rural Electrification Administration (REA) specification PE-89, type BJFC and flooded (filled) with a petrolatum - polyethylene translucent gel compound applied in a Liquid State. Furnish cable applicable for direct burial service, installations in underground conduit and aerial routing when supported by a separate messenger cable.

During pulling, lubricate the cable continuously as it enters the conduit. Use lubricant compatible with the cable jacket as recommended by the cable manufacturer. Use liquid detergent. Do not exceed the cable Manufacturer's recommended pulling speed and pulling tension.

Furnish Cable with conductors of solid, soft drawn, annealed bare copper, and insulation of solid, virgin high density polyethylene or polypropylene, with standard telephone industry color coding. Cable core to be insulated conductors twisted in pairs, with shielding of 0.005 inch (0.13 mm) solid copper tape and overlap to provide 100 percent electrical shielding coverage. Furnish cable with black outer jacket, low density, high molecular weight virgin polyethylene and able to withstand sunlight and temperature variations.

Provide Cable with number of pairs as specified.

I. Loop Detector Wire. Furnish No. 14 AWG, THWN, stranded of a continuous length from the spliced connection to the pair of shielded conductors in the lead-in cable splice or controller terminal when directly connecting the loop wire. Protect the loop wire with a flexible vinyl plastic tubing, of 3/16 inch (5 mm) I.D., a minimum of 1/32 inch (1 mm) wall, and 1/4 inch (6.4 mm) O.D. Furnish tubing capable of resisting deterioration from oils and solvents and highly abrasion resistant with a smooth bore. Insert the wire into the vinyl plastic tubing for the full length from the point of splicing and place it into the slot with the number of turns as plans show, or as the Engineer directs. Install tubing of a continuous length from the point of splicing of the loop wire to the lead-in cable. Make no splices in the tubing. Push the wire carefully into the slots with a blunt tool to avoid damaging the insulation.

When placing the loop wire in the sawed slots, seal the ends of the tubing within the splice to prevent any entrance of moisture.

Twist all lengths of loop wires and tubing not imbedded in the pavement with at least five turns per foot (16 turns per meter), including lengths in conduits and pullboxes.

Where plans specify, provide a conduit fitting on a riser in lieu of a pullbox for detector wire and lead-in cable splicing. Include in payment the flexible vinyl plastic tubing and conduit fitting where spliced in the cost of the Loop Detector Wire.

J. Loop Detector Lead-in Cable. Install to connect the loop detector wire to the loop detector amplifier. Splice the lead-in cable to the loop wire in pullboxes with approved watertight splices meeting Item 1323.04. Solder the connections together in a butt splice or use approved crimping connectors in conduit fittings where plans specify (where the loop wire has no pullbox for splicing) and insulate each cable in the splice individually with approved weatherproof electrical tape. Wrap the entire splice with approved weatherproof electrical tape and finish the splice by enclosing it in approved heat -shrink tubing.

Provide twisted multi-pair lead in cable (as plans require). Install No. 14 AWG, shielded, polyethylene insulated, chrome vinyl jacketed cable rated 750 volts for 14 AWG. Ground the shield only at the amplifier.

Installations: allow excess cable at weatherheads and power service connections for sufficient drip loops.

Provide additional cable for pullboxes, connections to equipment and as specifications indicate in the method of measurement to insure sufficient slack in underground installations.

1323.02 Messenger Wire. Install messenger cable of copper clad steel, stranded and sized as specifications indicate, including lashing wire and all accessories as the plans and detail show.

Furnish messenger wire meeting the requirements of ASTM specification B228 grade 30 EHS with mechanical properties as follows:

City Size Designation	Strand Size	O.D. of Wire Approximate	Minimum Breaking Strength
1/4"	(3 Each) No. 9 AWG or (7 Each) No. 12 AWG	0.247" (6.27 mm) 0.242" (6.15 mm)	5,129 lb. (22,815 N) 5,670 lb. (25,221 N)
5/16"	(7 Each) No. 10 AWG	0.306" (7.77 mm)	9,196 lb. (40,906 N)
3/8"	(7 Each) No. 8 AWG	0.385" (9.78 mm)	12,890 lb. (61,786 N)

Install messenger wire with the entire load of signal equipment giving a sag of three percent of the span length. Exercise due caution when stringing and loading the messenger wire so that the strain poles, either momentarily or for any period of time, are not loaded to permanent set (load at yield stress).

Furnish lashing wire of No. 14 AWG bare solid copper wire and apply to tightly wrap all signal cable to the messenger wire at the rate of two turns per foot (six and one-half turns per meter). Terminate the lashing wire to the messenger with approved split-bolt connectors. With approval of the City Traffic Engineer, Contractor may use copper preformed lashing rods in lieu of the No. 14 wire.

Specifications for bull ring aerial corners, crossover clamps, three-bolt messenger clamps (guy grips), thimble eye through bolts and messenger hangers include drop forged steel and

hot dipped galvanizing in accordance with ASTM specification A-153 and a designed holding strength without slipping or breaking of at least 10,000 pounds (45,000 N).

Fasten the messenger wire at the poles with thimble eye through bolts (wood poles) or with two wraps around the pole (steel poles) and secure with a three-bolt messenger clamp with the wire end served into a 130 to five to seven inch (180 mm) mause. The City will permit self wraps at thimble eye through bolts and bull ring aerial corners.

1323.03 Connector Kits. Install connector kits meeting the requirements of Item 713.15 for the type plans specify, in accordance with the plans and details.

Furnish Fusible Type kits with UL Class CC - 600 Volt fuses, ten amp unless plans specify otherwise.

1323.04 Splice Kits. Provide all labor and materials where plans specify splicing or in accordance with the details or as the Engineer directs. Install Kits in compliance with ANSI C119.1 for "permanent water resistant cable splicing kit" and meet the requirements of Item 725.15. Splice ratings for series circuits are 5,000 volts.

Splice Multi-conductor (three or more conductors) cable in accordance with the details in Standard Drawing ES-3-9.

The City does not permit splices in saw cuts or conduit. Correctly measure the cable to prevent unnecessary or unapproved splices. Contractor may make splices in pullboxes, cabinets and as details show.

City must approve all splices incidental to the item of cable to be spliced.

CTCS underground splice boxes. Splice twisted-pair cables in waterproof splice cases located in City-owned pullboxes, or in aerial sectionalizer cabinets mounted on utility poles. Contractor must make underground splices in splice cases of the two-type closure system manufactured by PSI Telecommunications, Inc. of Burbank, California, or approved equivalent.

Use splice enclosures made of fiberglass, manufactured by Stahlin, model # J1210HPL, type 4X and model #J806HPL, type 4X or equivalent. Splice cables by attaching the conductors to the terminal blocks provided within the cabinets. Bond the cable shield to ground at only one end of each cable. Use 3M Scotchlox model 4460 Shield Connectors or equivalent to bond the cable to ground. At every sectionalizer cabinet and underground splice where a ground connection is available, do not bond the cable coming from the control center (incoming cable). (The bond for the incoming cable originates at the source of the cable). Bond all other cables exiting from each splice. If a ground connection cannot be obtained at a splice point, make all shields common to each other to obtain the bonding connection from the previous splice point.

The cost of tooling and splices shall be incidental to the installation of the cable.

1323.05 Connections. Notify City of Cincinnati forces to make connections with a live master or CTCS cable. Make connections with a de-energized master or CTCS cable. City of

Cincinnati will approve all connections and the Contractor-tested circuit before final connection to the energized master line.

When disconnecting a series lighting circuit to splice cables, notify Cinergy to provide the cut out and cut in service.

Cinergy personnel will make all connections and disconnects with the Cinergy's systems.

1323.06 Method of Measurement. Measure cable in place, complete and accepted. Aerial cable measurements include pole attachment hardware and splice enclosures. Lead-in cable measurements include poured epoxy insulated splices. Measure: (a) horizontally from center to center of pullboxes, poles, cabinets, power sources, and electrical devices with an additional allowance of five feet (1.5 m) at each pullbox, pole, etc. for slack and connections; and (b) vertically between pole or conduit outlets. When substituting single conductor power cable for multi-conductor cable, City will pay based on the required length of multi-conductor cable. Power cable includes any costs incurred to arrange the service installation by the supply agency.

Measure loop detector wire from the pullbox center to the pavement edge, the actual feet running in the pavement loop slots depending on the number of turns laid, and returning to the pullbox, plus five feet (1.5 m) at each end for slack and splice.

Measure messenger wire in place, complete and accepted, and including all necessary accessories such as thimbles, clamps, bullrings and lashing rod. Measure from pole center to pole center, or pole center to bullring, or bullring to bullring, as specifications require. The measurement does not include any length of messenger wire for attachment to poles, or bullrings by bending, lapping or wrapping.

Measure connector Kits in place as a complete unit, accepted, including fuses as required. Splice kits are normally included with the item of cable; however, where specified, measure splices in place, complete and accepted as a unit item.

1323.07 Basis of Payment. City will make payment for accepted quantities of cables, wire, connectors, and kits and full compensation for all labor, materials, tools, equipment and incidentals necessary for each item furnished complete, with all connections made and wiring tested and accepted.

Item	Unit	Description
1323	Foot (meter)	____ Cable/wire ____ conductor No. ___ AWG
1323	Foot (meter)	____ pair of TCCS Cable ____ AWG
1323	Foot (meter)	Service cable, ____ plex, No. ___ AWG

1323	Foot (meter)	Messenger wire, ___ strand No. ___ AWG, (___diameter) with accessories
1323	Each	Connector Kit, type ___ with 10 amp fuse (where applicable)
1323	Each	Cable Splicing Kit

Item 1324 Traffic and Lighting Controls

1324.01 Photo-Electric Cell. Provide photoelectric control with a solid state, cadmium sulfide type cell with hermetically sealed silicon rectifier and rated surge protector for a fail-safe operating 120 volts, 60 Hz. Also, include a built-in feature so that lighting circuits will remain energized in the event the photo control components become inoperative.

The relay contact rating is 500 watts minimum with an in rush capacity of 900 volt amperes and capable of operation within temperature range of 30° F to 130° F (−1° C to 55° C). Make relay contacts snap acting to minimize arching. Make switch leaves on which contacts are mounted independent of thermal elements.

The sensing element operating range is from 0.5 to 1.5 FC (5 to 16 lx) "ON" and 1.5 to 4.5 FC (16 to 50 lx) "OFF" operation foot candles. Provide a hermetically sealed cell with three locking type blades that fit a socket which meets E.E.I. Pub. No. 148 and N.E.M.A. Pub. No. 18 standards.

Furnish a device with a time delay of a least 15 seconds incorporated into the switching operation to prevent switching due to lightning. Include on the device a socket mounted on a pole top or bracket adapter with wiring terminals, and all mounting hardware.

Furnish and install three No. 14 AWG, 600 volt, type RHW/USE cables from the photo cell to the lighting controller. Observe the following color code:

Black Wire for "line"

Red Wire for "load"

White Wire for "Neutral"

Mount the photo-electric cell at least 25 feet (7.6 m) or more up on the designated pole above any artificial light or street lighting, and orient with the sensing element facing north.

1324.02 Street Lighting Relays. Provide Street lighting relays and install them in pullboxes or cabinets as plans specify in accordance with the plans and details. Use them where luminaires serve from underground vaults and where the use of street lighting controllers are precluded.

Provide relays for one or more luminaires as plans indicate, but restricted to serving no more than two 1,000 watt metal halide type luminaires.

Provide the relay in a weatherproof housing of aluminum, molded fiberglass or other approved non-corrosive material.

Equip the relay with normal closed type mercury wetted contacts rated for 30 amps (minimum) and with the coil operated at 120 volts. Adams & Westlake Cat. No. 1140-50-7A, Permatrol No. 64-RE-850 South Bend Controls, Inc. No. MRR-TD-6246 or approved equal.

Include with the relay an approved lighting arrestor with a 30 amp cartridge type fuse (UL Class SK-1) connected to the line side of the relay contacts.

Provide mounting brackets and approved non-corrosive hardware.

1324.03 Lighting and Traffic Control Disconnect Devices.

A. General. Install Street Lighting Controllers and/or safety switches of the size plans specify and in accordance with the details.

B. Enclosure. Provide a NEMA type 4X enclosure fabricated from No. 16 gage or heavier AISI Type 302, 303, or 304 annealed stainless steel. Fully weld all seams to and all fastenings in the assembly or mounting of the enclosures to conform to ASTMA A-320 (AISI-300 Series).

Furnish each enclosure with a door so constructed that it may not be opened when the disconnecting handle is in the "on" position.

The front mounted switch handle will not be part of the door. Make the door single piece full length construction, hinged on the left side (facing the front of the enclosure) with latching device dogs near the top and bottom.

Provide the door with a mechanism interlocking the door latch and the operating handle, including provision for padlocking both in the "on" and "off" position. The defeatable mechanism will use the following sequence when the operating handle of the disconnecting device is in the "on" position: (1) Release door latch with one hand on door latch handle while simultaneously operating door latch defeater screw with a screwdriver in the other hand. (2) Open door with one hand on door latch handle while simultaneously operating disconnect handle defeater screw with a screwdriver in the other hand.

Recess the door latch defeater screw sufficiently within its housing so that it cannot be turned with a coin or flat washer.

Provide the door latch mechanism so the door handle must be turned to fully engage its latch before the disconnect handle can be moved to the "on" position.

C. Components. Furnish the enclosure with the following factory wired units mounted on a removable panel:

1. One two-pole or three-pole (as indicated below) heavy duty fusible disconnect switch rated for 600 volt class.

a. Three pole -- for street lighting controllers.

b. Two pole, three wire, two fusible poles with solid neutral -- for safety switches.

Install adjustable fuse clips and sized for up to 250 volt cartridge type fuses. Furnish fuses that are 120 or 240 volt size as per the voltage application required and UL Class RK-1, fast acting, current limiting with minimum 200,000 amps interrupting capacity; BUSS Limitron Series, E-Shawmut Amp-Trap Series or approved equal. Furnish switches with fuses as specifications indicate in Table 1324.03. Cable sizes for copper cables only.

Table 1324.03

Enclosure Size (Amperes)	Power Cable No./Size (AWG)	Enclosure Nominally Furnished Fuse Size (Amperes)	Power Service Conduit Riser	Neutral Bar Lug Sizes
200	3 #3/0 Cables 2 #3/0 Cables	200	2" (53 mm) 2" (53 mm)	2 each #3/0 to 250 kcmill 8 each #4 to 4/0
100	3 #1 Cables 2 #1 Cables	80	1-1/2" (38 mm) 1-1/4" (32 mm)	2 Each #1 to 2/0 8 Each #4 to 1
60	3 #4 Cables 2 #6 Cables	45	1-1/4" (32 mm) 1 inch (25 mm)	2 Each #4 to 1 8 Each #8 to 4
30	3 #6 Cables	25	1 inch (25 mm)	10 Each #8 to #4

Where requiring 240 volts, use sizes specified with three wires. For 120V systems use sizes specified with two wires.

2. One neutral bar with ten tubular screw lugs size as per Table 1324.03.

3. One Cabinet ground lug.

4. For Street Lighting Controller Only. One three pole lighting contactor. Contactor coil 120 volts, 60 Hz. with contacts rated for tungsten and ballast lamp loads as follows:

a. 480 volts maximum line to line voltage.

b. 277 volts maximum line to neutral voltage.

c. 250 volts DC.

d. One three-position Selector Switch, rated minimum ten amps, 600 volts, for "HAND OFF-AUTO" control.

e. Locate the switch inside the enclosure.

f. (Furnish only if specified) A Time Delay Relay "time out with Power interruption" type 120V 60 Hz, two each SPST or one DPDT isolated contacts rated ten amps minimum approximately one to 60 second timer set for 20 seconds, Ambient Temperature Range -40° to +120° F (-40° to +50°C). Furnish relay equipped with surge protection and Octal Socket. Potter-Brumfield Model CDB-38-70012 or approved equal.

5. Enclosure Facilities. Make provisions for connecting external wiring into the enclosure. Mark the "line" and "load" leads and make them easily accessible.

a. Provide two mounting flanges on the outside of the enclosure, one on the top and one on the bottom the flanges to be drilled or slotted for mounting bolts or screws with no sharp corners or burrs.

b. Furnish cabinet large enough to admit a three-inch (75 mm) conduit hub in either top, bottom, or back near bottom to allow entrance of external circuits and not disturb normal function of internal units.

c. Drill a 3/8" weep hole in the bottom of the cabinet to provide for the dispensation of moisture. Provide wiring space of two inches (50 mm) between housing and internal units. Furnish each switch enclosure with a padlock. Padlocks to be master No. 500 KA series or equal by Russwin, Corbin or others but keyed to accept master No. 255 key change.

6. Mounting Hardware. Furnish Mounting hardware, galvanized steel lag screws (for wood pole mounting) or stainless steel banding 1/16 x 7/8 inch (1.5 x 22 mm) dimension (for steel pole mounting).

Mount the enclosure on poles with the top of the enclosure ten foot (3 m) above grade.

1324.04 Traffic Signal Controller, Installation Only. The work of this item consists of hauling and installing the signal control equipment, including signal controller, detector amplifiers, control cabinet with base (for ground mounted types), all of which the City of Cincinnati will furnish in accordance with the details and plans.

Make the installation complete and ready to operate from a 120 volt, 60 Hz. electrical service.

Make all terminal strip connections between the controller and signal heads, pedestrian signals, signs, detectors, push buttons, and de-energized interconnecting cable. Install and wire all control equipment to produce the intended color sequence display and signal operation.

Where specifications call for the cabinet as the ground mounted type, install the cabinet on the foundation provided under Item 1319.01.

Where specifications call for the cabinet as the pole mounted type, install galvanized hanger plates on the cabinet using stainless steel nuts and bolts and maintaining the cabinet watertight. The cabinet to be fastened to wood poles with galvanized lag screws and to steel

poles with 1/16 inch by 7/8 inch (1.5 x 22 mm) stainless banding. For steel poles, install a three inch (80 mm) galvanized steel or cast aluminum conduit ell from the cabinet bottom into a nipple welded in the pole for a wiring raceway, unless otherwise specified. Install a pole mounted cabinet with 2/3 of the cabinet height five feet (1.5 m) above ground and mount on the side of the pole away from the street (field side), as plans show.

1324.05 Auxiliary Traffic Control Cabinets.

A. General. Furnish and install traffic control cabinets as plans specify, including all components and parts as required for each type of application intended or specified for the cabinet. Furnish each unit complete, ready for service and installed in accordance with the plans and details.

B. Cabinet. Provide a cabinet of corrosion resistant, weatherproof, NEMA type 3R, constructed of cast aluminum material with strength equivalent to 3/16 inch (5 mm) thick material having a minimum yield strength of 18,000 pounds per square inch (125,000 kPa) or corrosion resistant steel sheet at least 0.06 inch (1.5 mm) thick or 16 gauge AISI type 302, 303 or 304 annealed stainless steel.

Provide a cabinet free of cracks, burrs, blowholes, casting flashes and any excess material or imperfections.

Cast or construct a gasket groove around the periphery of the door and/or cabinet housing and insert a neoprene gasket in the groove to provide a watertight and dust tight seal between the door and housing.

Provide a double hinged door with stainless steel hinge pins and a latch bolt, steel armored, self-locking with a dust cover keyed to the City of Cincinnati standard (Corbin Key Change No. 1R 6380).

Paint the exterior of an aluminum cabinet with an aluminum color finish coating accordance with Item 1317.

Furnish cabinets equipped with fans and all ground mounted (Type G) cabinets with vents at the top (where fan is furnished) and at lower sides of the cabinet. Provide vents suitably baffled and screened for protection against moisture, dust and insects.

Furnish Cabinet doors, except door-in-door, with a bar stop-catch to retain door in an open position at an angle of between 120 degrees and 135 degrees.

Furnish Type PL and G cabinets with a door-in-door (police door) located in upper front center of cabinet door. Provide the door-in-door with gasket as plans specify for the main cabinet door to provide a water and dust tight seal. The door-in-door provides access to a recessed panel or wall but not the interior of the cabinet. Make the recessed panel of sufficient size to house up to five switches and a manual control cord.

Make the key for access to the door-in-door Corbin No. 0357SGS, Crousehinds No. KL-3123, Eagle Signal Company No. E-7322 or approved equal having the same key change.

C. Installation. Provide pole mounted (Type P and PL) cabinets equipped with mounting flanges or plates on the top and bottom for fastening to poles. Furnish mounting hardware and accessories for fastening to wood and steel poles. Field drill conduit entrances into the cabinet and only into the bottom of the cabinet.

Field drill pedestal mounted (Type P and PL) cabinets for mounting on the specified pedestal. Provide all nuts, bolts and washers for securing cabinet to pedestal of stainless steel, cadmium plated or corrosion resistant metal. Provide a neoprene or suitably equivalent gasket to seal the pedestal hub to the cabinet. Furnish the pedestal (Item 1318.02 specifies "pedestals") and provide it with a flanged hub which will be incidental to the payment of the cabinet.

Furnish ground mounted (Type G) cabinets with base and anchor bolts. Make the foundation, anchor bolt construction, size and placement as detail sheet indicates for Type I (regular). Install the cabinet on the foundation provided under Item 1319.01.

D. Components for All Types and Applications. Furnish Cabinets with the components as specified herein and as Table 1324.F.2 lists for the traffic control application specified.

1. Lighting Arrestor to meet the following minimum requirements:

    a. Voltage Class: 125 volts - single pole.

    b. 60 Hz Sparkover: 1000 volts rms.

    c. Critical Impulse Sparkover: 2400 volts

    d. (1-1/1 x 40 MS wave).

    e. Discharge voltage at 10,000 amps: 900 volts

    f. (10 x 20 MS wave).

Install the arrestor on the line side of the 50 Amp fuse (where furnished), otherwise on the line side of the main circuit breaker.

2. Provide Circuit Breakers of high-magnetic trip type suitable for the cabinet as plans specify, with atmospheric temperature range of from -20° to +120° F (-30° to +50° C). Provide each circuit breaker of the size Table 1324.F.2 specifies, and have a manual switch for on-off and reset operation.

3. Provide Common Neutral Terminal Bus of solid copper or brass of the tubular screw type sized for No. 4 to No. 14 gauge wires. Make the number of poles required Table 1324.F.2 specifies.

4. Make Terminal Strips the barrier type rated for a minimum of 600 volts insulation. Provide terminal poles rated a minimum of 30 amps and tubular screw type with pressure plate

sized for from one to five each No. 14 gauge wires. Make number of poles required as Table 1324.0F.2 specifies.

5. Provide a Panel Board and/or shelf constructed of minimum 1/4 inch (6 mm) rigid noncombustible, high insulated (minimum 600 volts), moisture resistant material.

6. Furnish a Relay Fuse, panel mounted type with socket and cap. Provide fuses of glass tube type, 125 volt (unless Table 1324.F.2 indicates otherwise), slow blow, dual element.

7. Provide Load Relays of DPDT-Double break with a minimum life of two million cycles and operable within an ambient temperature range of from -67° to +140° F (-55° to +60° C).

Provide the coil rated for 120 volts with the pull-in voltage between 95 to 102 volts AC RMS. Provide contacts rated a minimum 15 amps incandescent lamp load at 120 volts and 30 amps resistive load at 240 volts AC RMS with an inrush current rating of at least 240 amps. Make contacts silver cadmium oxide with gold flash.

Make insulation between all elements and ground a minimum 1,500 volts AC RMS.

Construct relay sockets with knife switch type contacts 1/4 inch wide by 1/16 inch thick (6 mm wide by 1.5 mm) thick of cadmium-plated phosphor bronze. Make insulation between all contacts and ground a minimum 1,200 volts AC RMS.

8. Provide Control Relays rated for continuous duty, double break with a minimum life of one million cycles and operable within an ambient temperature range of from -20° to +140° F (-30° to +60° C). Provide the coil rated for 120 volt service. Furnish contacts rated a minimum 5 amps inductive load at 120 volts ac. rms. and 10/5 amps resistive load at 120/240 volts ac. rms.

Make insulation between all elements and ground a minimum 500 volts.

Provide relays plastic encased and furnished with a commercially available octal (eight pin) keyed, high dielectric phenolic socket.

Furnish all interior cabinet wiring of the sizes and colors details show and of THW or THWN insulation rated for 600 volts.

Make all interior cabinet wiring not indicated on detail sheets THW or THWN and sized adequately for the fuse and/or breaker rating and color coded according to N.E.C.

E. Components for Reversible Lane Control Station Cabinets.

1. Load Center - Furnish one 20-amp circuit breaker for the Type I station. Furnish one 20-amp and one 15-amp circuit breaker for the Type II Station.

2. Provide a Heavy Duty Rotary Power Selector Switch two sections or decks, non-shorting five position, break before make. Furnish the contacts with a minimum make and break

rating of five amps at 115 volts AC resistive load. Provide the insulated decks of steatite or ceramic rated for minimum of 600 volts between contacts and ground. Ensure that indexing between contacts is a minimum of 20 degrees to maximum of 36 degrees. Make the switch bushing mounted with pointer knob and install in an aluminum enclosure for surface mounting on panel board.

F. Components for Relay Stations Only.

1. Provide a chassis with cover at least 11 inches wide by 17 inches long by two inches deep (300 mm by 450 mm by 50 mm), 18 gauge zinc plated finished steel.

2. Ensure that relays meet the requirements for Paragraph D.8 control relays.

3. Provide a variable resistance element consisting of a 69 watt, 125 volt incandescent standard traffic signal lamp with porcelain cleat type receptacle.

Table 1324.F.1
Cabinet Types - Dimensions

Dimensions							
Cabinet Type	**Height**		**Width**		**Depth**		**Notes**
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	
Type "P" Pole or Pedestal Mounted	21 inches (550 mm)	24 inches (600 mm)	14 inches (350 mm)	17 inches (450 mm)	12 inches (300 mm)	14 inches (350 mm)	Inside Dimensions
Type "PL" Pole or Pedestal Mounted	36 inches (900 mm)	42 inches (1,000 mm)	21 inches (525 mm)	24 inches (600 mm)	14 inches (350 mm)	16 inches (400 mm)	Outside Dimensions
Type "G" Ground Mounted	*46 inches (1,200 mm)	*50 inches (1,250 mm)	28 inches (700 mm)	32 inches (800 mm)	15-1/2 inches (400 mm)	20 inches (500 mm)	*Including Base

Table 1324.F.2
Cabinet Applications - Components

Specification Paragraph Reference	Components	Unit	Controller Installation		Sampling Detector or Counting Station			Reversible Lane Control Station	Relay Station	Multi-Speed Advisory Sign Control Station	School Flasher Time Control
	Cabinet Type		PL	G	P	PL	G	P	P	P	P
1	Lighting Arrestor	Each	1	1	1	1	1	1	1	1	
2	Circuit Breaker No. & Current Size	Number Size	2 30	2 30	1 15	1 15	1 15	2* 1 –15 & 1-20	1 15	2 15	2 15
3	Neutral Bus (Minimum) No. of Poles	Number of Poles	12	15	10	12	15	8	5	10	1
4	Terminal Strip No. of Poles (Minimum)	Number of Poles	40	50	20	30	40	11	30	20	4
5	Panel Board (Width x Height)	Inches (mm)						12 x 9 (300 x 230)			
	Shelf No. Required	No.		1	1	2	3			1**	
6	Relay Fuse (Amp Capacity)	Amp.						2 Each 2A 150V	5		
7	Load Relays	No.						2		3	
8	Control Relays	No.							11		Time Clock***

* **Note 1**: Furnish Load Center with main rating of 40 amps, surface mounted with cover.

** **Note 2:** Furnish where plans specify Detector Amplifier(s) with this cabinet. Shelf shall be incidental to payment of cabinet.

*** **Note 3:** City will furnish time clock for school flasher time control.

G. General Information. The purpose of the relay station is to maintain an acceptable voltage level (i.e., above 105 volts) on the interconnecting cable by refreshing the line with new service at specified locations.

Where plans specify "controller installation" application, payment of this item includes procuring the specified controller equipment (dial units, panel board, relays, etc.) from the City and remounting controller equipment in the specified cabinet. This is in addition to the required components of this specification. The City shall supervise, inspect and advise Contractor as to the methods and arrangement of installing the equipment in the cabinet.

Where other items refer to this specification for cabinet construction and components, City will make payment under that specified item.

1324.06 Method of Measurement. Measure photo-electric cells as a complete unit in place, including socket, mounting hardware and wiring to the disconnect device.

Measure street lighting relays as a complete unit in place, including enclosure, components and mounting hardware.

Measure lighting and traffic control disconnect devices as a complete unit in place including padlock, fuses and mounting hardware.

Measure traffic signal controller as a complete unit in place, including connections and mounting hardware.

Measure auxiliary traffic control cabinets as a complete unit in place, including all components per the application specified, wiring and mounting hardware.

Measure auxiliary control equipment as a unit installed, connected and tested.

1324.07 Basis of Payment. City will make payment at the Contract unit price bid per each item as specified and as full compensation for all labor, materials, tool, equipment and incidentals necessary for each item the Contractor furnishes complete, connected, tested and accepted.

Item	Unit	Description
1324	Each	Photo-electric cell
1324	Each	Street lighting relay
1324	Each	Street lighting controller, ___ amp
1324	Each	Safety switch, ___ amp
1324	Each	Traffic signal controller, ___ mount type, including control equipment, installation only
1324	Each	Reversible lane control station type ___
1324	Each	Relay station
1324	Each	Control cabinet, type ___ mounted (Installation only option)
1324	Each	School flasher time control

Item 1325 Street Lighting Luminaries

1325.01 Luminaires.

A. General. Install luminaires of the type the plans specify and consisting of a complete lighting device, including housing, supporting hardware, reflector (as plans require in the specified type) refractor, socket, lamp, integral ballast (or where plans specify remote ballast), disconnection devices, terminal block for external wiring connections, photo-electric cell receptacle and incidentals as required. Provide the luminaire to be capable of operating the specified lamp in a completely sealed optical system (as required in the specified type) at the line voltage specified. The luminaire to provide the ANSI-IES Type distribution and cut off as specified.

The light source for the luminaire to be specified.

B. Luminaire Types.

1. Standard Roadway Type: indicates a cobra head style housing designed for mounting on bracket or mast arms.

2. Underpass Type: indicates a "wallpack" type housing designed for wall mounting.

3. Post Top Mounted Type: indicates a decorative "colonial" or "modern" style luminaire for post top mounting.

4. Spherical Roadway Type: indicates a decorative, classic, spherical shaped fixture resembling an "eye ball" for use with high (40 foot [12 m] or more) mounting heights and mounted on short slip-fitter arms.

C. Interchangeability. The refractor interchanges with the "standard" refractor of the same wattage and type luminaire. "Standard" refractors are manufactured by the General Electric Company, Westinghouse Electric Corporation, Holophane Company, McGraw-Edison Company, and J. H. Spaulding Company.

D. Supply Voltage. The luminaire operates as specifications require herein when the primary voltage has the specified nominal value, or is within tolerances the specified ballast requires. The primary voltage is normally 240 volts, unless otherwise specifications indicate otherwise, for all luminaire types except the spherical roadway type, which is 120 or 240 volts or multitap as plans specify.

E. Housing. Provide luminaire enclosures that conform to the construction and material specified herein for the type luminaire plans specify.

1. Standard Roadway Type. These are luminaires of cast aluminum with natural finish or a painted finish in light gray. The housing for the luminaire has a two or three piece design consisting of the upper housing and a refractor holding lower door. Where the luminaire is of a three piece design, the third piece has a lower access door for access to internal

components independent of the refractor door and is located to the rear of the refractor door toward the house side. Ensure that lower door assemblies hinge away from the upper half on the house end.

Ensure that the lower door assemblies include latching mechanisms located on the street side and closeable with one hand.

Ensure that the refractor holding door permits easy removal of the refractor without the use of tools and has a safety catch to prevent accidental removal.

Provide an access door for access to internal components or mount the components on the door.

Make the slipfitter adjustable to fit pipe brackets from 1-1/4 inch to two-inch pipe (30 mm to 50 mm) brackets. Ensure that the slipfitter permits an adjustment in the vertical plane of plus or minus 5 degrees and the luminaire has a slipfitter stop which allows an engagement of at least 4-1/2 inches (115 mm) of the bracket arm.

2. Underpass Luminaire. Install housing for the underpass type luminaire as cast aluminum with natural finish or a painted finish in light gray; provide with conduit mounting holes for wire entry and secure to a wall or vertical surface with two each 3/8 inch (10 mm) bolts through the rear of the fixture. Ensure the fixture opens easily with a quick snap hinged ring or approved latching device. Protect the refractor by means of an approved guard or shield.

3. Post Top Luminaire. Ensure that housing for the post top mounted type luminaire is cast aluminum with a slip-fitter suitable for a three-inch (75 mm) O.D. tenon, unless plans specify otherwise. Provide three sets of screws or two bolts to facilitate leveling and securing the fixture on the pole. Hinge the luminaire on one side (colonial style) and secure with a captive screw on the opposite side. Where plans call for the modern style luminaire, use a captive hand nut to allow easy (no-tool) assembly and disassembly of the canopy.

Paint the luminaires black, pole green or other (per Item 1317) as plans indicate.

4. Spherical Roadway Luminaire. Make one piece seamless spun aluminum housing for the semi-spherical roadway type luminaire. Luminaire size varies by location. Furnish fixtures for installation in the downtown core approximately 26 inches (660 mm) in diameter and 17-1/2 inches (445 mm) high with a 750 watt metal halide light source. Provide Spaulding number WN3-A-P75-H3F-Q-CC or approved equal.

Furnish fixtures for installation in the Downtown perimeter (frame) approximately 22 inches (560 mm) in diameter and 14 inches (356 mm) high with a 400 watt metal halide light source. Provide Gardco number MA22-1-4X-400PSMH-QUAD-SC or approved equal.

Construct door of formed aluminum with clear flat tempered glass lens. Provide door that is fully gasketed and hinged to housing. All access hardware and screws are to be captive variety.

Furnish segmented anodized aluminum reflector capable of providing IES Type III light distribution for horizontal lamp orientation.

Incorporate between the bottom of the housing and the reflector portion of the optical system a low brightness baffle designed to minimize visibility of the light source from a horizontal distance greater than five mounting heights from the luminaire.

Make the housing support an extruded ten inches (254 mm) aluminum arm and 5RPA adapter. Firmly support complete luminaire and all its parts. Provide a mechanical adjustment to allow about the axis adjustment as well as vertical adjustment of up to 25 degrees. Completely seal the optical system.

Make all parts of the luminaire assembly weatherproof and capable of withstanding winds to 100 mph (160 kph).

5. Painting. Ensure that all exposed parts of luminaire are factory painted. Paint aluminum parts after anodizing.

a. Prime coat (submarine epoxy) – 4.6 wet mils (117 µm) thickness.

b. Intermediate coat – 7.0 wet mils (178 µm) thickness.

c. Final coat - Cincinnati MALT Pole Beige: Federal Standard Color 20372; or Foy-Johnson No. 29842 or equal by Porter, Wilson, or Pratt & Lambert - spread at rate of 300 ft^2/gallon (7 m^2/L) or 5.3 wet mils (135 µm) thickness.

6. Make all type housings complete with components weatherproof, and mount all components including ballast internally unless otherwise specified. Ensure that the refractor, reflector and ballast system are easily removable. Ensure that the luminaire will withstand winds to 100 miles per hour (160 kph).

F. Reflector. Make the reflector readily detachable and removable and in spherical roadway type luminaires supported from its top, the reflector to consist either of pressed prismatic heat resisting glass with sealed and spun-on cover, or a spun aluminum diffused material with aluminum-coated (Alzak) finish. Ensure that the inner surface of the reflector is smooth, non-porous and easily cleaned.

Provide reflectors in all type luminaires except the post top mounted type.

G. Refractor. Make the refractor of heat and high impact resistant material of polycarbonate or a heat resistant borosilicate glass or approved equal and design it so that it can be installed only in the correct position in the refractor holder. Ensure that glass is well annealed and free from imperfections and striations.

Ensure that refractors for lamp of 250 watts or greater are constructed from heat resistant borasilicate glass or approved equal.

Ensure that the refractor is embossed to clearly indicate the street side and house side prisms.

Ensure that panels used with the colonial style post top mounted luminaire are white frosted.

Ensure that for spherical roadway type luminaires the bottom of the reflector is covered with a gasketed door containing a large refractor.

Type A Refractor: Make this a clear non-prismatic crystal glass for resisting breakage due to heat and mechanical stresses, well annealed and free from imperfections and striations. When in place and with the luminaire operating, the window should withstand a heavy sprinkling of ice water.

Type B Refractor: Make this a convex refractor with prisms meeting the requirements previously specified for refractor material of polycarbonate or glass.

H. Optical seal. This consists of compressible, heat resisting nonlatex, resilient gasketing material to seal out insects, dust, dirt and water effectively. The material must provide a complete sealing of the optical system at the point of entry of the socket into the reflector and between the reflector and the refractor. Make the gasket readily removable from the reflector.

Post top mounted type luminaires do not require an optical seal.

Provide standard roadway type luminaires with a carbon filter to eliminate accumulation of dirt and other foreign matter in the optical system.

I. Ballast. Furnish each luminaire with a single-lamp ballast. Mount the ballast internally unless plans specify otherwise. Provide a ballast with a high power factor of at least 90 percent. Ensure the ballast is capable of starting lamps in temperatures as low as -20° F (-30° C), and is rated for the circuit voltage and size of lamp plans specify.

Attach a nameplate identifying the electrical and mechanical characteristics of the ballast as a permanent part of the ballast.

Provide a ballast that has the wattage rating of the lamp specified and the weight of the internal ballast that does not exceed 30 pounds (14 kg). Allowable ballast losses listed in Table 1326.02 are considered average losses.

Where multi-tap or "quad" voltage ballasts are specified, supply ballasts internally wired for connection to the circuit voltage specified in the Contract and plan sheets.

Where plans specify, furnish epoxy encapsulated external ballasts, suitable for aerial, post top, pole base or vault installation and enclose them in a corrosion free weathertight aluminum tank. Provide the ballast with a minimum of 12 inch (300 mm) long leads for external connection and lead wiring insulation rated for such service.

In addition to the foregoing general characteristics, provide ballasts that conform to the following characteristics for the type specified:

Ballasts for Mercury Vapor Lamps. Furnish and install the constant wattage or regulator type with separate primary and secondary windings delivering rated lamp current at circuit voltage variations of plus or minus 13 percent.

Ensure that the regulation output of lamp wattage does not exceed a total range of four percent for lamps rated 400 watts or less or six percent for lamps rated in excess of 400 watts.

Ballasts for Metal Halide Lamps. Furnish and install the peak load auto regulator type delivering rated lamp watts within plus or minus ten percent with plus or minus ten percent variations in applied voltage.

Ballasts for High Pressure Sodium Lamps. Furnish and install the regulator type with isolated primary and secondary windings for up through 400 watts. For 1,000 watt lamps, make ballasts the auto regulator type. In both cases the ballast delivers rated lamp current at circuit voltage variations of plus or minus ten percent.

Include starter components in ballasts. Make the starter component of solid state devices capable of withstanding ambient temperatures of 212° F (100° C). Make the starter to provide timed pulsing with sufficient follow-through current to completely ionize and start all lamps meeting published ANSI standards. Provide field replaceable starters completely interchangeable with no adjustment necessary for proper operation. They will have push on-type electrical terminations to provide good electrical and mechanical integrity and ease of replacement.

Treat the starter circuit board in an approved manner to provide a water and contaminant resistant coating. Ensure that the starter circuit-ballast combination is designed to consistently provide the following parameters:

1. Lamp wattage must be maintained within the trapezoid recommended by lamp manufacturers within the full rated input voltage range.

2. Amplitude of the pulse 2,500 volts minimum and 4,000 volts maximum. Operation of the pulse at spike voltage levels near minimum is desirable.

3. Minimum pulse width one microsecond at 2,250 volts, applied within 20 electrical degrees of the peak of the open circuit voltage wave, with a minimum repetition rate of one pulse per cycle of the 60 cycle wave.

4. Ensure that pulses are present when ballast is correctly wired when applying nominal voltage less 15 percent to the ballast windings.

5. Protect the high pressure sodium ballast, including starting aids, against normal lamp failure modes. Ensure that ballast operates with the lamp in an open or short circuit condition for six months without significant loss of ballast life. Ensure that the luminaire Manufacturer supplies ballast electrical data and lamp operating volt-watt traces for nominal

and plus or minus ten percent rated line voltage to verify ballast performance and compliance with ANSI lamp specifications, for the rated life of the lamp.

J. Socket. Make the socket of a rugged high grade porcelain body with a mogul screw shell type base and rated for 600 volts (5,000 volt impulse for high pressure sodium lamps). Make the socket shell from nickel or nickel plate and having lamp grips to prevent the lamp from loosening. Ensure that when the lamp is in its normal operating position, the porcelain of the socket body covers all metal on the lamp base.

Make the socket adjustable in standard roadway type luminaires to provide other ANSI-IES type distributions. Provide a means of identification to associate each lamp position with each distribution. For socket adjustment, provide positive positionings by means of index holes, lugs or notches. the City will not accept slots with infinite settings. In underpass type luminaires make the socket position to be adjustable to give a 60 or 70 degree beam angle.

K. Lamp. Furnish a lamp with each luminaire of the type source and wattage specified in accordance with Item 1326.

Make lamps for the spherical roadway type luminaire of 1,000 watt Metal Halide.

L. Fastening, Wiring and Disconnecting Devices. Make all required hardware of approved non-corrosive material.

Use slotted head type fastening devices in standard roadway type luminaires.

Disconnect devices are designed to prevent electrical hazard to personnel servicing the fixture before approval by the City.

Connect the end of each conductor not connected to the socket to a terminal block by spade terminals or other suitable removable connectors.

Provide a terminal block with enough terminals for incoming service wires, ground wire for safety, socket connections, and ballast connections for both internal and remote ballast location. Make the terminal block easily accessible.

M. Wiring Diagram. Provide a schematic wiring diagram and attach it to the interior of the luminaire in a permanent manner.

N. Photometric Data. Ensure that the luminaire reflector and refractor give an IES distribution for the type luminaire specified unless otherwise.

1. Provide a standard roadway type. Medium-Semi cutoff and Type II or Type III as plans specify.

2. Provide an underpass type designed to direct all useful light below the normal viewing angle, resulting in high utilization of lumen output.

3. Post top mounted type (Type V unless plans specify otherwise)

4. Spherical roadway type (Type A refractor)
(Type B refractor)

Spherical roadway type luminaire photometrics:

With Type A (Clear) Refractor - Beam Spread = 122° vert. x 122° horiz.
Max candle power = 31,751

With Type B (Prism) Refractor - Beam Spread = 134° vert. x 167° horiz.
Max. candle power = 17,121

O. Photo-Electric Receptacle. Provide all standard roadway and post top mounted type luminaires with a receptacle with shorting cap for City-wide interchangeability purposes. Ensure that the receptacle meets EEI-NEMA standards and is a twist-lock type. Wire the receptacle for 120 volts and provided it with an easy adjustment for orienting to the north. Maintain weather sealing, moisture and dust proofing.

P. Weight and Area. Make luminaires complete and ready for service to comply with the following weight and projected area requirements:

Table 1325

Luminaire Type		Size by Wattage	Maximum Projected Area in ft^2 (m^2)	Maximum Weight in Pounds (kg)
1	Standard Roadyway Type	100-175	1.6 (0.15)	35 (16)
		200-400	1.6 (0.15)	55 (25)
		700-1,000	2.5 (0.25)	60 (27)
2	Underpass Type (Not Applicable)			
3	Post Top Mounted Type (Colonial and Modern Types)	70-175	2.0 (0.20)	35 (16)
		200-400	3.8 (0.35)	55 (25)
4	Spherical Roadway Type	up to 1,000	4.4 (0.40)	50 (23)

Q. Installation. Mount luminaires mounted on poles to adjust vertically and horizontally to provide the required mounting height and specified alignment with the roadway. Where the profile grade exceeds 4 percent, orient the luminaires so that the vertical axis of the luminaire is perpendicular to the longitudinal centerline of the roadway at that location.

Mount luminaires on walls level. Where mounting more than one luminaire on the same wall, mount them at the same elevation so as to present a straight line appearance.

Mount luminaires mounted on post tops level and in line with the vertical axis of the post.

1325.02 Method of Measurement. Measure luminaires as a complete unit in place, including lamp and all components and testing.

1325.03 Basis of Payment. The City will make payment at the Contract unit price bid for each luminaire, by type, and as full compensation for all labor, materials, tools, equipment, and incidentals necessary to furnish and install each luminaire complete, connected, tested and accepted.

Item	Unit	Description
1325	Each	Luminaire, ___ watt, ____ +volt, ___ (light source), ___ type.

Item 1326 Lamps

1326.01 Traffic Signal Lamps. Include a lamp in each traffic signal optical section that conforms to the ITE specification "A Standard for Traffic Signal Lamps", with the following exceptions and qualifications:

A. Furnish and install brass screw bases with a rotational adjustment feature.

B. Install lamps with the base rotated so the open portion of the lamp filament is in an upward position.

C. Provide lamps with a minimum rated life of 8,000 hours with the exception of 135 and 150-watt lamps which shall have a minimum rated life of 6,000 hours.

D. Provide 60-, 90- and 135-watt lamps that are Krypton gas filled.

Provide lamps for the respective signal equipment in accordance with Table 1326.01 (on following page).

Include the cost of furnishing and installing lamps in the bid price of each signal item.

Table 1326.01
Traffic Signal Lamps

	Size/Type	Watts	Rated Volts	Light Center	Industrial Lamp Number	Rated Life (Hours)
Vehicular Traffic Signal Heads	8 Inch Sections	60	120/125	2-7/16" (62 mm)	60AT19 or 60A19TS Clear	8,000
	12 Inch Arrow Indications	90	120/125	3" (75 mm)	90AT19 or 90A19/1/TS Clear	8,000
	12 Inch Sections	135	120/125	3" (75 mm)	135AT19 or 135A19TS Clear	6,000
Pedestrian Signal Heads	12 Inch 2 Section Type A2	90	120/125	3" (75 mm)	90AT19 or 90A19/1/TS Clear	8,000
	18 Inch 3 Line Type D2	60	120/125	2-7/16" (62 mm)	60AT19 or 60A19TS Clear	8,000
Optically Programmed Signal Head	12 Inch Sections	150	115		M-123/131 Sealed Beam	6,000

Include the cost of furnishing and installing lamps in the bid price of each signal item

1326.02 Lamps for Street Lighting Luminaires. Furnish a lamp with each luminaire that conforms to ANSI Specifications C-78 for all HID (Hi Intensity Discharge) type lamps. Make all lamps first line, high quality having heat resistance clear glass envelopes, except make all mercury vapor lamps the deluxe white type.

Where plans specify incandescent type lamps, install lamps meeting the requirements of Federal Specification number W-L-101.

Ensure that HID lamps by size conform to the following characteristics of the Table 1326.02.

Provide high pressure sodium lamps with a ceramic arc tube interior. Ensure that lumen output at end of economic life (67 percent of rated life) is not less than 80 percent of initial lumen rating. Ensure that rated life for high pressure sodium lamps is at ten hours start, and all high pressure sodium lamps are 100 volt lamps. Initial lumens shown are for horizontal burning.

All performance data in Table 1326.02 reflect normal operating conditions.

Ensure that metal halide lamps have a quartz arc tube interior. Provide that lumen output at the end of economic life is not less than 65 percent of the initial lumen rating.

The rated life for metal halide lamps is at 10 hours start.

Lamp Warm-Up Time to 80% Light:

Mercury Vapor .....five to seven minutes.
High Pressure Sodium.....three to four minutes.
Metal Halide.....three to five minutes.

Lamp Re-Strike Time:

Mercury Vapor .....three to six minutes.
High Pressure Sodium.....one minute.
Metal Halide.....ten to 15 minutes.

Table 1326.02
High Intensity Discharge Lamps and Ballast Losses

Lamps					Ballasts
Type	Lamps (Watts)	Industrial Lamp No. by ANSI Code and Spec. No.	Rated Horizontal Initial Lumens	Rated Life (Hours)	Loss (Watts)
Mercury Vapor	100	H38JA-100/DX-C78.1300	4,000	24,000	27
	175	H39KC-175/DX-C78.1308H	8,150	24,000	35
	250	H37KC-250/DX-C78.1301	11,150	24,000	42
	400	H33GL-400/DX-C78.1305	21,500	24,000	60
High Pressure Sodium	70	S62	5,800	20,000	35
	100	S54	9,500	20,000	44
	150	S55 (55 Volt)	16,000	24,000	54
	150	S56 (100 Volt)	16,000	24,000	54
	200	S66	22,000	24,000	54
	250	S50	27,000	24,000	65
	310	S67	37,000	24,000	70
	400	S51	50,000	24,000	85
	1,000	S52	140,000	24,000	90
Metal Halide	70	M98	5,000	5,000	16
	100	M90	8,500	10,000	20
	175	M57	14,000	7,500	35
	250	M58	19,500	7,500	44
	400	M59	32,000	15,000	62
	1,000	M47	100,000	10,000	90

Item 1327 Traffic Signals

1327.01 Vehicular Traffic Signal Heads.

A. General. Provide signal heads that are in conformance with ANSI No. D10.1 or the latest revised ITE standard for "Adjustable Face Vehicle Traffic Control Signal Heads", whichever is more recent, except as noted otherwise herein. This specification also provides the minimum performance requirements for 12 inch (300 mm), eight inch (200 mm) and 12 inch (300 mm) arrow traffic signal modules. It is not intended to impose restrictions upon specific designs and material that conform to the purpose and intent of this specification. The specification refers to definitions and practices described in "Vehicle Traffic Control Signal Heads" published in the Equipment and Material Standards of the Institute of Transportation Engineers, referred to in this document as "VTCSH". The multiple LED light source should be the latest technology available on the market. Utilize LED's manufactured with AlInGaP technology for red, amber and yellow indications or InGaN for green indications.

All LED traffic signal lamps must meet or exceed all the requirements of the current Institute of Transportation Engineeers 9ITE PUBLICATION ST-011B Pedestrian Traffic Control Siganl Indications (PTCSI) and the current ITE specifications for Vehicle Traffic Control Siganl heads (VTCSH), Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Module, unless otherwise stated in the specifications herein.

Provide Gelcore, Dialight or pre-approved equal LED traffic signal lamps. Provide only latest model currently in production LED lamps that are new. Equipment no longer being manufactured will not be accepted even if it meets the following specifications.

Furnish the signal heads in the arrangements shown on the plans and details.

B. Design. Provide signal assemblies consisting of eight inch or 12 inch (200 mm or 300 mm) units rigidly fastened together in various combinations as specified. Ensure that the signal assembly is made in accordance with the Manual of Uniform Traffic Control Devices (MUTCD). Assemble the sections in such a manner as to prevent dirt or moisture entering into the unit, or the possibility of rotation or misalignment. Construct signals in such a way as to allow assembly or disassembly of individual sections with the aid of standard tools.

Make traffic signals capable of both vertical and horizontal mounting. Ensure that each signal section, electrical unit and optical unit is interchangeable with other signal heads of the same Manufacturer.

C. Housing. Provide the signal head, including the door and visor, of polycarbonate material, or as otherwise specified. If plans specify no material, furnish signal heads in ay of the above approved materials. Provide all parts, including hardware, of non-corrosive materials.

Normally, make eight inch signal head size ten inch by ten inch (250mm x 250mm) and 12 inch signal head size 14 inch by 14 inch (356 mm x 356 mm). The City will not accept signal heads exceeding these dimensions by more than 1/2 inch (12 mm).

Polycarbonate Construction. Make the housing of each signal section one-piece virgin ultra-violet stabilized polycarbonate resin black in color. Make the unit by injection molding and have a minimum wall thickness of 0.100 inches (2.5 mm). Equip all sections with metal inserts in the housing to prevent stripping of threads in areas that require constant removal of fastening devices (such as the door) on a regular maintenance basis. Connect no electrical wiring or terminal block to the housing by use of self-taping screws in such a manner as to allow the connections to loosen if terminal generates heat resistance. Make the polycarbonate material strong enough to withstand a 70 foot-pound (95 Nm) impact without fracture or permanent deformation.

Alternate Construction (Aluminum). Where specified, construct the housing of each signal section of one piece dense cast aluminum.

Housing General. Make the area around the upper and lower openings ribbed or reinforced so as to be capable of handling breaking strengths that the ITE Standards (Section 3.01-6) specify.

Provide each housing with serrated round bossed openings at the top and bottom so that it rotates about a vertical line and is capable of being securely fastened at increments of no more than seven degrees.

After assembling the unit, drill a 3/8 inch (10 mm) drain hole for water drainage.

D. Door. Attach the door to the housing with stainless steel hinge pins and design it in a manner that does not allow the door to become accidentally detached when mounted in either a vertical or horizontal position. Design the door's locking device so that technicians do not require tools to open and close the door. Make the color of the door yellow.

E. Visor. Make visors as one molded piece in the "Tunnel" style, NOT the angle type. Make the visor with a longitudinal rectangular cutout in the bottom. Tilt the visor at an eight degree angle and equip it with four lugs, each with stainless steel or brass machine screws to hold it in place. Locate the lugs to permit rotating of the visor 90 and 180 degrees relative to the door. Securely fasten the visor to the door with the lugs, but make it removable with simple tools. Make the visor color black.

The length of the visor will vary depending on the signal specified on the plansheets.

1. For eight inch (200 mm) traffic signal heads, make the length seven to eight inches (175 mm to 200 mm).

2. For 12 inch (300 mm) traffic signal heads, make the length ten to 12 inches (250 mm to 300 mm).

F. Optical Unit. Equip each signal section with a neoprene or other approved resilient gasket, adequately sealing the lens to the door to assure a dust and moisture tight optical system. Install units in the optical system in a manner permitting easy replacement.

1. Reflector. Make the reflector of the Alzak process, or approved equal, highly polished specular finished aluminum type. Make it easily replaceable without replacing the reflector holder. Make the reflector holder easily replaceable and hinged to the signal housing to allow easy access for replacing lamp.

2. Lamps. Lamps will come with each signal section. Table 1326.01 indicates size and characteristics.

3. Lamp Receptacle. Make the lamp receptacle of a heat resisting material and designed to properly position a medium screw base traffic signal lamp. Provide the receptacle with an antivibration device and a positive locking device so that the socket will not turn when installing the lamp. Make provision on the receptacle and/or the reflector to permit rotation of the lamps so that the leadin wires are in the upward position, and to secure the lamp in this position. Make the lamp receptacle the fixed prefocus type designed for a lamp light center length of 2-7/16 inches (62 mm) for eight inch (200 mm) signals and three inch (75 mm) for 12 inch (300 mm) signals.

4. Lens, Incandescent. All lenses are the circular convex type in eight inch (200 mm) or the 12 inch (300 mm) size. The "ARROW" lenses are always 12 inch in size. Equip each 12 inch (300 mm) signal section with the wide angle type lens. Ensure that lenses are fabricated of durable polycarbonate impact-resistant plastic, or approved equal. Provide a neoprene gasket between the reflector and the lens to assure a dust and weatherproof seal between these components when the door is closed and latched to the housing. Fasten the lens to the door by use of machine screws and lugs and make it removable with simple tools. Ensure that all lenses conform to ITE and ANSI standards.

G. Physical and Mechanical Requirements, LED Optical Units. Provide LED traffic signal modules with expanded view (the module) designed as retrofit replacements for existing signal lamps that do not require special tools for installation. Provide retrofit replacement LED modules that fit into existing traffic signal housings built to VTCSH standard without modification to the housing.

Provide retrofit replacement LED signal modules that can be installed by simply removing the following existing components: lens, lamp module, gaskets. Provide replacement modules that fit securely and are weathertight in the existing housing and connect directly to existing electrical wiring.

Removal of the existing incandescent lamp reflector is optional. Provide LED optical units that retrofit to Peek Traffic/TCT, NO TCPSS83K300P, Peek Traffic/TCT NO ESS83K300P or LFE TRAFFIC CONTROL DIVISION, Eagle Signal No. SIG. 103A1111BYB or LFE TRAFFIC CONTROL DIVISION, Eagle Signal No. SIG. 130A1111BYB or approved equal traffic signal housing units.

1. LED Signal Module.

a. Tinting (Optional) – Tint lens or use transparent film or materials with similar characteristics.

b. The LED module lens may be a replaceable part without the need to replace the complete LED module.

c. The configuration of the LED arrow is illustrated in Figure 1327.01.

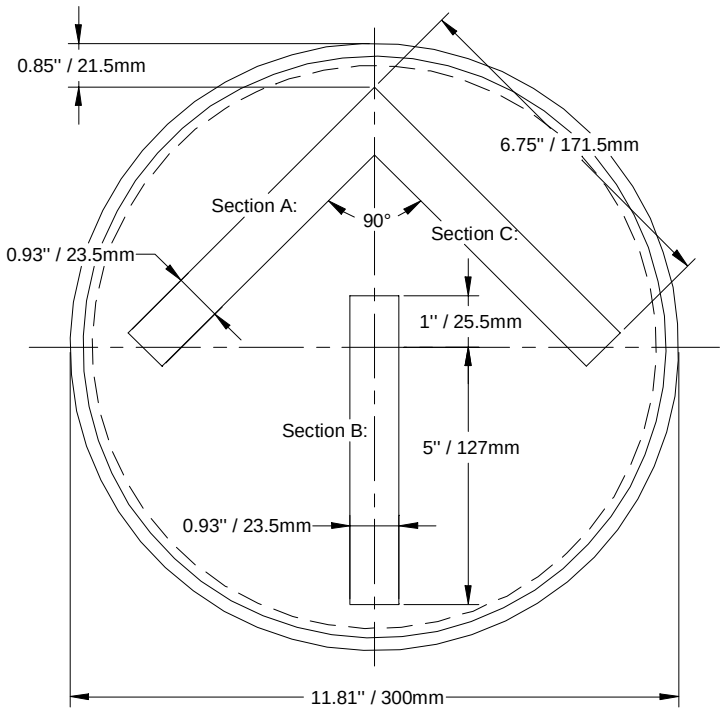


Figure 1327.01 – LED Arrow Configuration

2. Environmental Requirements.

a. Provide LED module rated for use in the ambient operating temperature range of –40° F to +165° F (-40° C to +74° C).

b. Protect the LED module against dust and moisture intrusion as per NEMA Standard 250-1991 requirements for Type 4 enclosures. Protect all internal LED, electronic and electrical components.

c. Provide LED signal module lenses that are UV stabilized.

d. Provide LED signal module lenses that are smooth on the outside and specifically designed to reduce sun reflections (sun phantoms).

e. Supply the LED module with an installed gasket.

3. Construction.

a. Provide LED modules that are single, self-contained devices, not requiring on-site assembly for installation into existing traffic signal housings. The power supply must fit and mount inside the LED module.

b. Design the assembly and manufacturing processes for the LED assembly to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

4. Materials.

a. Conform to applicable ASTM specifications for materials used in the lens and LED module construction/manufacture.

b. Construct enclosures containing the power supply and electronic components of the LED module of UL94VO flame retardant materials. The lens of the LED module is excluded from this requirement.

5. Module Identification.

a. Identify each LED module on the back side with the Manufacturer's name and the units serial number.

b. Indentify the following operating characteristics: nominal operating voltage, power consumption, and volt-amperes.

c. Provide all LED modules with prominent and permanent vertical indexing indicators (i.e., Up Arrow or the word "Up" or "Top") for correct indexing and orientation inside the signal housing.

H. Photometric Requirements – LED Optical Units.

1. Luminous Intensity and Distribution.

a. Furnish LED modules that provide the maintained minimum luminous intensity values shown in Tables 1327.A, B and C throughout the warranty period under the operating conditions defined in sections 1327.01.G.2.a and 1327.O.4.b.

b. Furnish LED modules that provide measured chromaticity coordinates between 500 nm and 650 nm when operating within the temperature range specified and conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

c. Furnish LED modules whose optical assemblies diffuse the light output and provide uniform illumination across the entire surface of circular lenses. Provide LED modules whose individual LED's are not visible to the observer of indications displayed.

Table 1327.A – Maintained Minimum Luminous Intensity for Expanded View LED Signal Modules – 12-Inch Signal

Vertical Angle (Degrees)	Horizontal Angle (Left & Right) (Degrees)	12-Inch Signal		
		Red	Yellow	Green
-17.5	17.5	3	7	7
	2.5	10	20	20
-12.5	17.5	14	27	27
	2.5	20	41	41
-7.5	17.5	20	41	41
	2.5	54	108	108
-2.5	17.5	58	115	115
	2.5	220	441	441
+2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178
	22.5	38	77	77
	27.5	16	32	32
+12.5	2.5	50	101	101
	7.5	48	97	97
	12.5	44	89	89
	17.5	34	69	69
	22.5	22	44	44
	27.5	16	32	32
+17.5	2.5	22	44	44
	7.5	22	44	44
	12.5	22	44	44
	17.5	22	44	44
	22.5	20	41	41
	27.5	16	32	32
+22.5	2.5	10	20	20
	17.5	7	14	14

Table 1327.B – Maintained Minimum Luminous Intensity for Expanded View LED Signal Modules – 8-Inch Signal

Vertical Angle Down (Degrees)	Horizontal Angle (Left & Right) (Degrees)	8-Inch Signal		
		Red	Yellow	Green
2.5	2.5	133	267	267
	7.5	97	194	194
	12.5	57	113	113
	17.5	25	48	48
7.5	2.5	101	202	202
	7.5	89	178	178
	12.5	65	129	129
	17.5	41	81	81
	22.5	18	37	37
	27.5	10	20	20
12.5	2.5	37	73	73
	7.5	32	65	65
	12.5	28	57	57
	17.5	20	41	41
	22.5	12	25	25
	27.5	9	16	16
17.5	2.5	16	32	32
	7.5	14	28	28
	12.5	10	20	20
	17.5	9	16	16
	22.5	6	12	12
	27.5	4	9	9

Table 1327.C – Maintained Minimum Luminous Intensity for the LED Vehicle Arrow Traffic Signal Modules

Vertical Down (Degrees)	Horizontal Angle (Left & Right) (Degrees)	12-Inch Signal		
		Red	Yellow	Green
2.5	2.5	60	150	90
	7.5	44	110	66
	12.5	25	62	38
	17.5	14	35	21
7.5	2.5	40	100	60
	7.5	36	90	54
	12.5	26	65	39
	17.5	16	40	24
	22.5	7	17	11
	27.5	3	7	4
12.5	2.5	9	23	14
	7.5	9	22	14
	12.5	8	20	12
	17.5	6	15	9
	22.5	4	10	6
	27.5	3	7	4
17.5	2.5	4	10	6
	7.5	4	10	6
	12.5	4	10	6
	17.5	4	9	6
	22.5	4	8	5
	27.5	3	7	4

2. Chromaticity.

a. Provide LED modules with measured chromaticity coordinates between 500 and 650 nm, conforming to the chromaticity requirements of section 8.04 and Figure 1 of the VTCSH standard.

I. Electrical Requirements – LED Optical Units.

1. General.

Furnish wiring and terminal blocks that meet the requirements of section 13.02 of the VTCSH Standard. Provide two secured, color coded, 36 inch (914 mm) long 600 volt, 20 AWG minimum jacketed wires, conforming to the NEC, rated for service at +220° F (+105° C) for electrical connection.

2. 15.2 Voltage Range.

a. Furnish LED modules capable of operating from a 60 ± 3 cycle AC line power over a voltage range from 80 to 135 volts AC RMS. The current draw must be sufficient to ensure compatibility and proper triggering and operations of load current switches and conflict monitors in the signal controller that the procuring traffic authority customer has in use.

b. Nominal operating voltage for all measurements is 120 ± volts RMS.

c. Furnish units whose luminous intensity is not affected by more than ± ten percent by fluctuations in lline voltage over the range of 80 to 135 volts AC.

d. Furnish LED circuitry that prevents flickering at less than 100 Hz over the voltage range specified in Section 15.2.1.

e. Low Voltage Turn Off. Furnish modules that do not illuminate when the applied voltage is less than 45 volts AC. Test for this condition by first fully illuminating the unit at the nominal operating voltage. Then, reduce the applied voltage to the point that there is no illumination. That point must be greater than 45 volts AC. The same requirement applies to raising the voltage from 0 to 45 volts AC with no visible illumination.

f. Turn-On and Turn-Off Time. Furnish modules that reach 90 percent of their full illumination (turn-on) within 100 msec (± 10 msec) after the application of the nominal operating voltage. Furnish modules that are not illuminated (turn-off) within 100 msec (± 10 msec) after the removal of the nominal operating voltage.

3. Transient Voltage Protection.

Furnish LED modules containing on-board circuitry that includes voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992.

4. LED Drive Circuitry.

a. Wire the individual LED light sources so that the catastrophic failure of one LED will result in the loss of the light from only that one LED.

b. Provide current regulated power supply.

5. Electronic Noise.

Provide LED modules and associated on-board circuitry that meets Federal Communication Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

6. Power Factor (PF) and AC Harmonics.

a. Provide LED modules that have a power factor of 0.90 or greater when operated at nominal operating voltage and at 77° F (25° C).

b. Provide LED signal modules that do not induce total harmonic distortion into an AC power line exceeding 20 percent at nominal operating voltage at 77° F (25° C).

7. Wattage.

Provide LED modules that are less than or equal to the base wattages shown below at 77° F (25° C).

Type	Wattage
12" (300 mm) Red Ball	10 or less
12" (300 mm) Yellow Ball	22 or less
12" (300 mm) Green Ball	14 or less
12" (300 mm) Yellow Arrow	10 or less
12" (300 mm) Green Arrow	7 or less
8" (200 mm) Red Ball	6 or less
12" (200 mm) Yellow Ball	14 or less
12" (200 mm) Green Ball	8 or less

J. Terminal Block. Equip the signal head assembly with a barrier type terminal block having five poles for three or four section signal heads and seven poles for five section signal heads. Terminate wiring from the lamp sockets and external cable connections at the terminal block.

Make the terminal block easily accessible and removable. Mount he terminal block to the interior of the signal assembly with approved nuts, bolt and washers. City will not accept sheet metal screws.

K. Wiring. Make wiring of the signal head assembly color coded, No. 18 stranded copper fixture wire rated at 300° F (150° C), 300 volts, types PF, SF, or equal per Article 310-2(a) and 402 of NEC for incandescent units.

L. Color. Impregnate the color into the resin material to make the color of the polycarbonate signals permanent. The color is as follows:

1. The back and visors are black.

2. The front or doors are yellow.

M. Weight. The maximum weight of each signal head is as follows:

Product	Maximum Weight in Pounds (kg)
12 Inch (300 mm) Sections Polycarbonate Type	8 (3.5)
8 Inch (200 mm) Sections Polycarbonate Type	4 (1.8)
12 Inch (300 mm) Sections LED Type	10 (4.5)
8 Inch (200 mm) Sections LED Type	6 (2.7)

N. Quality Assurance for LED Optical Units.

1. General.

a. Quality Assurance Program. Manufacture LED modules in accordance with a Vendor quality assurance (QA) program. Furnish only products from Vendors whose QA programs include two types of quality assurance: (1) design quality assurance, and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of LED modules built to meet this specification.

b. Record Keeping. Keep QA process and test result documentation on file for a minimum period of seven years.

c. Conformance. Do not label, advertise or sell LED module designs as conforming to this specification if they do not satisfy design qualification testing and the production quality assurance testing performance requirements of Sections 21.3 and 21.4

2. Manufacturer's Serial Numbers. Indentify each LED module with the Manufacturer's serial number for warranty purposes.

3. Production Quality Assurance (QA) Testing. Test all new LED modules in accordance with the following Production Quality Assurance testing regimen prior to shipment. Reject any LED module that does not meet the requirements of thes QA Tests. Maintain QA test results per the requirements of Section 21.1.2.

a. Module Burn-In. Energize all LED modules or the electronic circuitry sub-assemblies, including all LEDs for a minimum of 24 hours at 100 percent on-time duty cycle at an ambient temperature of +140° F (60° C).

b. Maintained Minimum Luminous Intensity. Test all LED modules for maintained minimum luminousity after burn-in. A single point measurement with a correlation to the intesnsity requirements of Tables 1, 2 or 3 in Section 14.0 may be used. Operate the LED modules at nominal operating voltage and at an ambient temperature of 77° F (25° C).

c. Power Factor. Test all LED modules for power factor after burn-in per the requirements of Section 15.6.1. A commercially available power factor meter may be used to perform this measurement.

d. Current. Measure all LED modules for current flow in amperes after burn-in. Compare the measured current values against current values resulting from design qualification measurements in Section 21.4.4.1. Reject LED modules exhibiting measured current values in excess of 120 percent of the design qualification current values.

e. Visual Inspection. Visually inspect all LED modules for any exterior physical damage or assembly anomalies.

4. Design Qualification Testing. Perform design qualification testing on new LED module designs, and when a major design change has been implemented on an existing design. The minimum sample quantity of LED modules shall be as stated for each test. Failure to meet requirements of any of these tests shall be cause for rejection.

Perform testing once every five years or when the module design or LED technology has been changed. Retain test data at the testing laboratory and at the LED module Manufacturer for a minimum period of five years.

a. Burn-in. Energize LED modules for a minimum of 24 hours, at 100 percent on-time duty cycle, in an ambient temperature of +140° F (60° C) before performing any design qualification testing.

b. Maintained Minimum Luminous Intensity.

I. After burn-in, test a random sample of six LED modules for maintained minimum luminous intensity at each of the 44 points indicated in Tables 1, 2 and 3 in Section 14.0. Take and record these measurements at an ambient temperature of 77° F (25° C) after the signal has been operated for 60 minutes.

II. After burn-in, test a random sample of six LED modules for maintained minimum luminous intensity. Mount signals to be tested in a temperature testing chamber so that the lensed portion of the signal is outside the chamber and all portions behind the lens are within the chamber at a temperature of 165° F (74° C). Maintain the air temperature in front of the lens of the signal lens at a minimum of (120° F (49° C) during all tests.

Test red and green LED modules for luminous output at 165° F (74° C). Allow the modules to achieve thermal equilibrium for 60 minutes, while the modules are energized at nominal operating voltage, at a 100% duty cycle. Take and record a single luminous intensity measurement.

Test yellow LED modules for luminous output at 77° F (25° C). Allow the modules to achieve thermal equilibrium for 60 minutes, while the modules are energized at nominal operating voltage, at a 8.3 percent (or 1/12) duty cycle or (5 sec On/55 sec Off).

Make a single point correlation measurement, accounting for measurement variables, at 77° F (25° C). Make a measurement for red and green at 165° F (74° C) with the lens at 120° F (49° C). Correlate the 165° F (74° C) measurement factored to the 77° F (25° C) measurement to the requirements of Table 1, 2 & 3 in Section 14.0. Reject LED modules not meeting this correlation.

III. Chromaticity. Measure a sample of two LED modules for chromaticity per the requirements of Section 14.2. Use a spectroradiometer for this measurement. Make this measurement at an ambient temperature of 77° F (25° C).

IV. Electrical.

i. Current. Measure a sample of six LED modules for current flow in amperes. Use the measured current values for quality comparison of Production Quality Assurance current measurements on production modules.

ii. Power Factor (PF). Measure a sample of six LED modules for power factor per the requirements of Section 15.6.1. Use a commercially available power factor meter to perform this measurement.

iii. Total Harmonic Distortion (THD). Measure a sample of six LED modules for total harmonic distortion per the requirements of Section 15.6.2. Use a commercially available total harmonic distortion meter to perform this measurement.

iv. Electronic Noise. Test a sample of one LED modules per the requirements of Section 15.6, with reference to Class A emission limits referenced in FCC Title 47, SubPart B, Section 15.

v. Controller Assembly Compatibility. Due to the low load current draw and high off-state impedance of LED modules, perform the following design qualification tests to ensure the module design is compatible and operates properly with load current switches and conflict monitors in NEMA and Type 170 traffic signal control units.

α. Load Switch Compatibility. Test a sample of six LED modules for compatibility and proper operation with load current switches. Connect each LED module to a variable AC voltage supply. Monitor the AC line current into the LED module for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80 volts RMS to 135 volts RMS. Reject LED modules whose current draw fails to ensure proper load current switch operation.

β. Signal Conflict Monitor Compatibility. Test a sample of six LED modules for compatibility and proper operation with signal conflict monitors. Operated each LED module from a 135 volt AC voltage supply. Wire a 19.5 kΩ resistor in series in the hot line between the LED module monitor and the AC power supply. Wire a single-pole-single-throw switch in parallel across the 19.5 kΩ resistor. Wire a 220 kΩ shunt resistor between the hot line connection and the neutral line connection and the neutral line connection on the LED module. Test conflict monitor compatibility by measuring the voltage decay across the 200 kΩ shunt resistor as follows: Close the single-pole-single-throw switch, shorting out the 19.5 kΩ resistor,

allowing the AC power supply to illuminate the LED module. Next, open the switch and measure the voltage across the 220 kΩ shunt resistor for a decay to a value equal to or less than ten volts RMS within a time period equal to or less than 100 milliseconds. Repeat this test a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

vi. Nondestruct Transient Immunity. Test a sample of six LED modules for transient immunity using the procedure described in Section 2.1.8, NEMA Standard TS 2-1992.

VI. Environmental.

i. Temperature Cycling. Perform temperature cycling on a sample of three LED modules per MIL-STD-883, Test method 1010. Make the temperature range in accordance with Section 2.3. Perform a minimum of 20 cycles with a 30-minute transfer time between temperature extremes and a 30-minute dwell time at each temperature. LED modules under test shall be non-operating. Reject any LED module that fails to function properly or exhibits any evidence of cracking of the LED module lens or housing after temperature cycling.

ii. Moisture Resistance. Perform moisture resistance testing on a sample of three LED modules per NEMA Standard 250-1991 requirements for Type 4 enclosures.

iii. Mechanical Vibration. Perform mechanical vibration testing on a sample of three (3) LED modules per MIL-STD-883, Test Method 2007, using three four-minute cycles along each x, y, and z axis, at a force of 2.5 Gs, with a frequency sweep from two Hz to 120 Hz. Reject any module that exhibits loosening of the lens, of any internal components, or other physical damage.

O. Warranty for LED Optical Units.

1. Replace or repair LED modules if an LED module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.

2. Replace or repair LED modules which exhibit luminous intensities less than the minimum values specified in Table 1 Section 3.0 within the first 60 months of the date of delivery.

P. Mounting. Include all mounting hardware for signal heads with the item furnished, as indicated in Table 1327 for the signal mounting or as indicated on the plans. The hardware will conform to City requirements as details show.

In accordance with the plans, mount signal heads alone, forming a one-way head, or combine with additional heads to form two-way, three-way, or a maximum of four-way heads. Furnish multi-way heads with appropriate top and bottom brackets with an opening in the center of the top bracket provided for mounting purposes. Using pipe spacers, correct signal face height inequalities for multi-way heads for proper accommodation between top and bottom brackets.

Observe the requirements that the bottom of all signals and signs on a span shall be level with one another, with a minimum of 17 feet (5.2 m) clearance between the equipment and the roadway. This is usually measured at the crown of the roadway.

Table 1327
Sign and Signal Mounting Hardware

Mounting Type *S = Span Wire* *M = Mast Arm* *B = Bracket Arm* *P = Pedestal Top*	**Sign and Signal Equipment**			
	Traffic Signal Head	**Pedestrian Signal Head**	**Internally Illuminated Signs**	**Lane Use Control Signal Head**
Mounting Hardware	**Mounting Type**			
6 inch (150 mm) drop-forged, hot dip galvanized suspension clamp.	S		S	S
Adjustable clevis.	SM			SM
Combination balance adjuster and weatherhead	SM		SM	SM
Mast arm hanger or clamp	M		M	M
Pole clamps	B		B	
Clamshell Hardware		BP		
Post top reducer and coupling			P	
1-1/2 inch (40 mm) galvanized steel for mast arms, span wire assemblies and pedestal top mountings. 1-1/2 inch (40 mm) aluminum for bracket arms or polycarbonate for bracket arms of 15 inches (380 mm) or shorter.**	SMB		SMB	SM
1-1/2 inch (40 mm) lock nuts, washers and all other incidentals necessary to make the Assembly complete, dust and watertight.	SMB		SMBP	SM
Required clearance from bottom of Equipment to grade.	17 feet (5.2 m)	Minimum 8 feet (2.5 m)	17 feet (5.2 m)	17 feet (5.2 m)

** All pipe and fittings are schedule 40.

Q. Aiming of Signals. The light distribution of the traffic signal reflector and lens will give the greatest intensity straight in front and slightly down from the signal face.

Aim the signals as follows:

Vertical Aiming. For level approaches, mount all traffic signals so as to hang plumb. Where the approach has an angle, signal housing tilt 1/4 inch per 24 inches (10.4 mm per m) of elevation above grade for each one percent of approach grade.

Horizontal Aiming. Unless the traffic signal plan indicates otherwise, aim traffic signal heads horizontally, based on the following:

1. Two Signal Heads on Approach.

a. Aim left signal head horizontally with the beam of maximum intensity directed at a point five feet (1.5 m) to the right of the center line of the approach roadway, at a distance of 200 feet (61 m) from the stop line.

b. Aim right signal head horizontally with beam of maximum intensity directed at a point five feet (1.5 m) to the left of the right hand edge of the approach roadway, at a distance of 200 feet (61 m) from the stop line.

2. Two Through Traffic Signal Heads and One Left Turn Signal Head.

a. Aim left turn signal horizontally with beam of maximum intensity directed at the center of the left turn storage lane, if present, at a distance of 200 feet (61 m) from the stop line. If the storage lane is in excess of 200 feet (61 m) long, or otherwise on the center line at a distance of 200 feet (61 m) from the stop line.

b. Aim left signal head for through movement horizontally with the beam of maximum intensity directed at the center of the farthest left lane available for through traffic at a distance of 200 feet (61 m) from the stop line.

c. Aim right signal head as 1.b indicates above.

3. Aim horizontal point for auxiliary signal heads for special advance visibility conditions and/or signal heads facing curved approaches as the traffic signal plan indicates, or as the City Traffic Engineer directs.

1327.02 Optically Programmed Signal Heads. Furnish optically programmed signal heads in the arrangements the plans show. Incorporate in each signal section an optical system projecting an indication programmed to be visible only within boundaries of a specific area shown on the plans. Ensure that the optical system is capable of being veiled anywhere to within 15 degrees of the optical axis using procedures and opaquing material in accordance with the manufacturer's instructions.

Signal sections conform to applicable portions of the ITE standard and the foregoing specifications for conventional optics traffic signal heads. Make optical sections of the 12 inch (300 mm) lens, and mounted alone or in combination with additional sections of optically programmed or conventional optics types to form signal faces and heads in the arrangements shown.

Make the components of the optical system:

1. Lamp
2. Lamp Collar
3. Optical Limiter-Diffuser
4. Objective Lens

Ensure that lamps have three prongs, a sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours. Couple the lamp to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter. Ensure that the optical limiter provides an accessible imaging surface that focuses on the optical axis for objects 900 to 1,200 feet (275 m to 365 m) distance, and permits an effective veiling mask to be variously applied as the desired visibility zone determines. Provide the optical limiter with positive indexing means and make it of heat resistant glass. Make the objective lens a high resolution planar incremental lens hermetically sealed within a flat laminant of weather resistant acrylic or approved equal. Make the lens symmetrical in outline; the lid may be rotated to any 90 degree orientation about the optical axis without displacing the primary image. Ensure that the optical system accommodates projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer. Ensure that the projected indication conforms to ITE transmittance and chromaticity standards.

The housing design of optically programmed sections includes a plus or minus ten degree tilt adjustment from the horizontal while maintaining a fixed mounting axis. Rigidly mount optically programmed signal heads to prevent visibility boundary movement due to high winds or truck movement. Mount signals mounted on span wire and tie to a tether cable by a breakaway clamp installed in the lower section mounting opening.

Include an incandescent lamp in each optical section and of the type Table 1326.01 indicates.

Make the housing die-cast aluminum parts and conforming to ITE alloy and tensile requirements, and having a chromate preparatory treatment. Finish the exterior of the signal case, lamp housing and mounting flanges with a high quality baked enamel prime and finish paint. Make the final color black. Paint the lens holder and interior of the case optical black. Predrill the signal case and lens holder for backplates and visors. Construct the hinge and latch pins of stainless steel. Seal all access openings with weather- resistant rubber gaskets. Ensure that sheet metal parts, including visors and backplates, conform to ITE material requirements, and include a chromate preparatory treatment and optical black on all surfaces.

Include mounting hardware in the Item furnished and as Table 1327 indicates or the signal mounting plans indicate. Ensure that hardware conforms to the requirements in the details. Make the tether cable 1/8 inch (3 mm) braided stainless steel cable.

1327.03 Lane Use Control Signal Heads.

A. General. The unit consists of a single housing containing optical parts, lamps and accessories for displaying by artificial illumination either a "Red X" or a "Green (Down) Arrow" indication as plans specify. Make the indications on an opaque background.

Ensure that testing conforms to the applicable provisions of Item 1313 - Testing.

B. Dimensions (Face Size).

Size	Type	Dimension				Strokes Of Indication	
		Width		Height			
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
12 inches (300 mm)	Single Indication	12 inches (300 mm)	14 inches (350 mm)	12 inches (300 mm)	14 inches (350 mm)	1-1/2 inch (40 mm)	3 inches (75 mm)

C. Colors and Dimensions. Ensure that colors and indication dimensions comply with the latest ITE Standard for "Adjustable Face Vehicle Traffic Control Signal Heads". The "RED X" cross bars have a minimum length of 15 inches (380 mm).

D. Optical Performance. Ensure that he color of lane use control signal indications is clearly visible for 1,320 feet (400 m) at all times under normal atmospheric conditions, unless otherwise physically obstructed. Ensure that the visibility angle of the lane use control signal is at least as great as plans specify for the standard circular traffic signal head. Design the signal to minimize the effect of sun phantom (i.e., reflection of incident [outside] light rays) to provide the maximum blankout effect of any indication not illuminated.

E. Single Indication Type. Ensure that lane use control signals of the single indication type meet the latest ITE Standards for "Adjustable Face Pedestrian Signal Heads" with the following supplements. Plans specify the indication.

1. Make the reflectors highly polished specular finished aluminum.

2. Make lens of prismatic glass diffusing type with fired on legends with opaque masking on back of lens to maximize blankout effect.

3. Make lamps the clear type and installed with the open portion of the filament in the upward position.

4. The lamps and rating for the signal head is:

Signal Size	Minimum Life (Hours)	Rated Watts	Light Volts	Center	Industrial Lamp Number
12 inch (300 mm) Signal	8,000	121	125	3 inches (75 mm)	121 A/TS
18 inch (450 mm) Signal	1,000	200	130	6 inches (150 mm)	200 PS 30/34

F. Housing. Make the housing of sheet aluminum, a corrosion-resistant aluminum, or aluminum-alloy die casting of sufficient strength of virgin ultraviolet stabilized polycarbonate resin. Weld all metallic joints continuously to prevent the entrance of moisture.

Make all screws, nuts, bolts and fastening devices used in the signal housing stainless steel. Mount all components in the housing/s so they are easily accessible without de-energizing or disassembling the signal.

G. Visor. Make the visor 18 gage (0.05") (12 mm) minimum aluminum or polycarbonate, securely attached to the housing, as paragraph G indicates. Ensure that the visor attached to the door does not interfere with the opening of the door.

Construct the visor so that the indication is shielded from direct sunlight when the sun is 45 degrees or more above the horizon.

H. Wiring. Wire the signal heads assembly with a minimum of 300°F (150°C), 600 volt, No. 18 AWG stranded copper fixture wire per articles 310-2 (a), 402 and 410 of the N.E.C.

Provide terminal strip rated at 600 volts with each pole rated at 15 amps for wiring connection to external control cable.

I. Painting. Paint aluminum equipment in accordance with Item 1317 and the following:

1. First coat (all surfaces) - Epon Oxide Baking Primer, Federal Spec. TT-P-636.

2. Second coat (all Surfaces) - Medium Gray Alkyd Urea Exterior Baking Enamel, Federal Spec. TT - E-480B.

3. Third coat (yellow surface) - Federal Yellow Alkyd Urea Exterior Baking Enamel, Federal Spec. TT-E-489F, Color 13538.

4. Third coat (green surface) - Dark Green Alkyd Urea Exterior Baking Enamel, Federal Spec. TT-E-489, Color 14062.

5. Third coat (flat black surface) - Alkyd Urea Black Synthetic. Heat-resisting Glyceryl Phyhalate Type 4, instrument black military Spec.E-5557.

J. Installation. Include mounting hardware in the Item furnished as indicated in Table 1327 for the signal mounting plans indicate. Ensure that the installation and all hardware conform to detail requirements.

Position signals over the center of the lane(s) plans specify except where plans indicate offset positioning.

Include the cost of furnishing and installing lamps in the bid price for the respective signal head.

1327.04 Pedestrian Signal Heads. Pedestrian signal heads conform to the ITE Specification "Adjustable Face Pedestrian Signal Head Standard," except as may be otherwise indicated below. The signal heads display alternately the legends "Hand" symbol in Portland Orange light and "Walking Man" in Lunar White light.

A. Housing. Type D2 Pedestrian Signal – Make the housing single piece cast aluminum with 1-1/2 inch (40 mm) reinforced mounting hubs on the top and bottom with serrated bossed openings. Make the door frame of one piece cast aluminum. Door fastens with a captive stainless steel wingnut, and latching or unlatching of the door requires no tools. Access to the lamps is direct by opening the door. Use stainless steel for all screws, nuts, bolts, and fastening devices used in each type signal housing.

All gaskets in each type housing which are exposed to the atmosphere are dust and moisture tight. Make the gaskets of neoprene or an approved equivalent. The City will not accept cork gaskets.

B. Dimensions. Table 1327.03 indicates signal head face dimensions.

Table 1327.03

	Face				Legend	
Signal Type	Width		Height		Symbol Height	
	Minimum	Maximum	Minimum	Maximum	Nominal	Tolerance
16" LED Type D2	13 inches (330)	16 inches (400 mm)	15-1/2 inches (395 mm)	18 inches (460 mm)	4-1/2 inches + 1/8 inch (115 mm ± 3 mm)	5/8 inch -1/32 inch +3/32 inch (16 ± 1 mm)

C. Arrangement of Symbols and Colors. The color for the "Walking Man" symbol is Lunar White and the color for the "Hand" symbol is Portland Orange. The colors are to comply with the color standards of the ITE Specification.

Type D2 Single Section LED Type Signal. The "Hand"symbol is in the left half and the "Walking Man" symbol on the right half of the lens. Make the face of 0.250 inch (6.5 mm) polycarbonate plastic and textured on outside surface. The "Hand" message is Portland orange when illuminated and the "Walking Man" message is Lunar white when illuminated. Make the symbols cutout type with black background; these produce bright and uniform messages even

in strong ambient lighting condition. When an optical section is not energized, that section blanks out so that the message is not readable even under very strong ambient lighting conditions.

D. Visor.

Make the visor of the "Eggcrate" design in one-piece injection molded polycarbonate plastic. Make the visor 1-1/2 inch (40 mm) deep with horizontal members spaced 1/2 inch (12 mm) apart. Place enough vertical members to assure holding the horizontal members parallel. Install the visor parallel to the face and mount to the door frame with stainless steel screws.

E. Painting. Paint the aluminum signal head in accordance with Item 1317 and the following:

Clean the unit properly and give the exterior of the housing and the entire visor one coat of chromate primer and two coats of automotive baking enamel. Bake each coat individually to a hard finish before applying the next coat.

F. Optical. The purpose of this specification is to provide the minimum performance requirements for the LED "Walking Man" and "Hand" icon pedestrian signal modules (hereafter called module or modules). This specification requires the following size (nominal message bearing surface): 16 inch by 18 inch (406 mm x 457 mm). This specification is not intended to impose restrictions upon specific designs and materials that conform to the purpose and the intent of this specification. This specification refers to definitions and practices described in "Pedestrian Traffic Control Signal Indications" published in the Equipment and Materials Standards of the Institute of Transportation Engineers, referred to in this document as "PTCSI" and in the Manual on Uniform Traffic Control Devices (MUTCD). This specification applies to modules purchased after the effective date of these specifications.

G. Physical and Mechanical Requirements LED Modules. Provide modules designed as retrofit replacements for existing pedestrian signal indication lamps that do not require special tools for installation. Provide retrofit replacement modules that fit into existing pedestrian signal housings built for the PTCSI sizes stated in Section 1 of the "Walking Man" and "Hand" icon pedestrian signal indication Standard without modification to the housing. See PTCSI 4.2.1 for housing sizes.

Provide retrofit replacement modules that only require the removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector, for installation into existing pedestrian signal housing. Additionally, provide retrofit replacement models that are weather tight, fit securely in the housing, and connect directly to existing electrical wiring.

1. The Module.

    a. Provide retrofit modules capable of replacing the optical unit.

    b. The module lens may be a replaceable part without the need to replace the complete module.

c. Provide modules that include full "Walking Man" and "Hand" icons (not outlines). The configurations of the "Walking Man" and "Hand" icons are illustrated in Figure 1 and Figure 2, respectively.

Figure 1

Figure 2

2. Dimensions for Figure 1 and Figure 2. For the nominal message bearing surface (module) size, use the corresponding height and width:

Height = 11 inches (280 mm)
Width = 7 inches (180 mm)

H. Environmental Requirements.

1. Provide modules rated for use in the ambient operating temperature range (measured at the exposed rear of the module) of -40° F to +165° F (-40° C to +°75 C).

2. Design the pedestrian module to meet NEMA 250 Hose down Test. Conduct the test on a stand-alone unit. Do not use protective housing.

3. Provide modules with UV stabilized lens.

I. Construction.

1. Provide modules that are single, self-contained devices, not requiring on-site assembly for installation into an existing traffic signal housings. Design the power supply to fit and mount inside the pedestrian signal module.

2. Design the assembly and manufacturing process for the module to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

J. Materials.

1. Use materials for the lens and LED module construction that conform to ASTM specifications where applicable.

2. Construct enclosures containing the power supply and electronic components of the LED module of UL94VO flame retardant materials. The lens of the LED module is excluded from this requirement.

K. Module Identification.

1. Indentify each module on the backside with the Manufacturer's name, model number(s) and serial number(s).

2. Identify the following operating characteristics: nominal voltage, power consumption, and Volt-Ampere.

L. Photometric Requirements.

1. Luminance, Uniformity & Distribution.

a. Provide modules capable of maintaining the minimum luminance values listed in Reference 1 and Reference 2 under the operating conditions defined in Sections 2.3.1 and 4.2.1 for a minimum period of 60 months. Make measurements perpendicular to the surface of the module at nine separate points on the icon. These values may decrease up to 50 percent from these table values beyond 15 degrees from the perpendicular in either to the left or right on a horizontal plane.

Reference 1 - Maintained Minimum Luminance Value
"Walking Man" icon of the Module
5,300 candelas/square meter

Reference 2 - Maintained Minimum Luminance Value
"Hand" icon of the Module
3,750 candelas/square meter

b. Provide modules with the uniformity of the "Walking Man" and "Hand" icons' illumination meeting a ratio of not more than one to five between the minimum and maximum luminance measurements (in Cd/m2).

2. Chromaticity. The standard colors for the LED Pedestrian Signal Module shall be White for the "Walking Man" and Portland Orange for the "Hand" icon. The colors for these icons shall conform to the CIE chromaticity diagram x, y coordinates as follows:

The white area is defined by the sum of these two areas that are contiguous, and are defined by the following lines:

	First Area	Second Area
Yellow Boundary	x = 0.400	x = 0.450
Blue Boundary	x = 0.280	x = 0.400
Green Boundary	y = 0.7917x + 0.0883	y = 0.7917x +0.0483
Purple Boundary	y = 0.4600x + 0.1810	y = 0.4600x + 0.2210

The Portland Orange area is defined as:

	First Area
Red Boundary	y = 0.331
Yellow Boundary	y = 0.390
White Boundary	y = 0.997 – x

M. Electrical.

1. General. Furnish wiring and terminal blocks that meet the requirements of Section 13.02 of the VTCSH Standard. Provide two secured, color coded, 36-inch (914 mm) long 600 volt, 16 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +220° F (+105°C), for electrical connection.

2. Voltage Range.

a. Provide LED modules that operate from a 60 $\pm$ 3 Hertz AC line power over a voltage range from 80 volts AC RMS to 135 volts AC RMS. Provide modules that have sufficient current draw to ensure compatibility and proper triggering and operation of load current switches and conflict monitors.

b. Nominal operating voltage for all measurements shall be 120 $\pm$ 3 volts RMS.

c. Provide LED modules whose luminous intensity is not affected by more than + ten percent by fluctuations in line voltage over the range of 80 volts AC to 135 volts AC.

d. Provide LED modules with circuitry that prevents flickering at less than 100 Hz over the voltage range specified in Section 4.2.1.

e. Low Voltage Turn Off. Provide modules that do not illuminate when the applied voltage is less than 35 volts AC RMS. Test each icon for this condition by first fully illuminating it at the nominal operating voltage and then reducing the applied voltage to the point where there is no illumination. This point must be greater than 35 volts RMS AC.

f. Turn-On and Turn-Off Time. Provide modules where each icon of the module reaches 90 percent of its full illumination (turn-on) within 100 msec. of the application of the nominal operating voltage. Provide modules that do not illuminate (turn-off) after 100 msec. of the removal of the nominal operating voltage.

g. Provide pedestrian signal units that default to the "Hand" symbol during abnormal conditions when nominal voltage is applied to the unit across the two-phase wires (rather than being applied to the phase wire and the neutral wire).

3. Transient Voltage Protection. Provide modules whose on-board circuitry includes voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1998, or the latest version.

4. Electronic Noise. The modules and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.

5. Power Factor (PF) and AC Harmonics.

a. Furnish modules that provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 77° F (25º C).

b. Provide modules that when operated at nominal operating voltage induce total harmonic distortion into an AC power line of 20 percent or less.

N. Quality Assurance.

1. General. Unless otherwise specified, conduct all of the required tests at an ambient temperature of 77° F (25° C) and at the nominal operating voltage of 120 volts AC RMS.

a. Manufacture modules in accordance with a Vendor quality assurance (QA) program. Furnish only products from Vendors whose QA programs include two types of quality assurance: (1) design quality assurance, and (2) production quality assurance. Include statistically controlled routine tests as part of the production quality assurance to ensure minimum performance levels of LED modules built to meet this specification.

b. Keep QA process and test result documentation on file for a minimum period of seven (7) years.

2. Conformance. Do not label, advertise or sell as conforming to this specification any module design(s) not satisfying design qualification testing and production quality assurance testing performance requirements.

3. Design Qualification Assurance.

a. Perform Design Qualification testing on new module designs, and when a major design change has been implemented on an existing design.

Unless otherwise specified, conduct all of the tests on the same set of randomly selected modules, hereafter called the sample set, at an ambient temperature of 77° F (25° C) and at the nominal operating voltage of 120 volts AC RMS.

b. Perform testing once every five years or when the module design or LED technology has been changed. Retain test data (by the module Manufacturer) for a minimum period of seven years and for a period of at least five years beyond the last date of manufacture of that model type.

4. Production Quality Assurance.

a. Subject all new modules to Production Quality Assurance testing prior to shipment. Reject any module that fails to meet requirements of the QA tests. Maintain QA test results for a period of four years.

5. Warranty. Provide the following warranty provisions from Manufacturer: LED signal modules(s) that fails to function as intended due to workmanship or material defects within the first 60 months from date of deliver will be replaced or repaired at no cost to the City of Cincinnati.

O. Optical Performance. Ensure that it is possible to discern which message is illuminated and that the message is readable to normal eyesight from a distance of 100 feet (30 m) on a bright, clear day, in direct sunlight, with the visor(s) removed.

P. Wiring. Provide each lamp receptacle with two coded No. 18 or larger insulted copper lead wires connecting the lamps to the terminal strip. Ensure that wiring has approved 600 volt insulation, capable of withstanding 221° F (105° C) and is long enough to provide easy accessibility without disconnection wires when opening the unit for service.

Q. Terminal Block. Locate a terminal block having a minimum of seven terminals so as to be easily accessible when opening the unit. Terminate wires for interior connections to the external wiring on this terminal block. Provide entry for external wiring through both the top and bottom mounting hubs to the terminal block.

R. Installation. Include mounting hardware in the item furnished, as indicated in Table 1327 for the signal mounting plans indicate.

Provide mounting hardware of "Clamshell" design, constructed of cast aluminum alloy, black finish. Dimensions not to exceed: 11-1/4 inches (286 mm) high by 5-1/2 inches (140 mm) wide by 2-3/4 inches (70 mm) deep. Design hardware to allow thru-bolt, lag screw or steel band mounting.

Secure the closed signal half of the assembly to the pole half of mounting hardware by use of a flathead socket bolt and tighten using a 3/16 inches (5 mm) Allen wrench.

Terminate field wiring on a horizontally mounted three-position terminal block located on the upper half of the signal mounted section of the mounting hardware.

Provide mounting hardware with a neoprene gasket to provide a weather tight seal.

Provide warranty for clamshell mounting bracket and hardware for two years from the date of shipment covering all materials and workmanship.

Ensure that the installation and all hardware conform to the detail requirements.

S. Manufacturer.

1. The D2 type Pedestrian signals are the Indicator Controls Corporation model 7037 without the clamshell mounting hardware or approved equal.

2**.** Pedestrian signals are the McCain model 1000 with the McCain clamshell mounting hardware or an approved equal.

1327.05 School Flasher, Installation Only. The work of this item consists of installing the school flasher assembly (the sign face, flashing amber beacons and illuminated speed numeral). City will furnish all equipment except mounting hardware.

Furnish and install the bracket arms of the length plans specify, and all pole mounting hardware and all accessories required to install the complete school flasher assembly.

Make all bracket arms 1-1/2 inch (40mm) schedule 40 galvanized steel pipe. Use galvanized pole plates with through bolts and leg screws on wood pole installations. Use galvanized pole clamps on steel pole installations.

Make the installation in accordance with the plans and details.

Furnish the school flasher time control where plans require under Item 1324.06.

1327.06 Covering of Traffic Signals. Not in Service - New: Keep all Signal heads installed but not in operation completely covered at all times with burlap, heavy corrugated cardboard, or other approved material, so that the signal lenses are not visible from any point. Remove or de-energize lamps in signal heads covered with cardboard, burlap, etc., until the covering is removed and the signals are put into operation. If the covers come off for any reason, the Contractor must recover them within 24 hours of notification. If the Contractor does not recover them, the City will do the work and charge the Contractor.

To Be Removed or Temporarily Disconnected: Cover the existing signal heads w-hen removed or temporarily disconnected from operation with burlap, heavy corrugated cardboard, or other approved material and remove or de-energize lamps until the Contractor removes or restores the signal heads. Do not remove existing signal heads until the new equipment is in

operation. If the covers come off for any reason, the Contractor must recover them within 24 hours of notification. If not, the City will do the work and charge the Contractor.

City will make payment for covering of traffic signals incidental to the various items of the bid, which require new, removed or temporary signal equipment.

Provide coverings for vehicular, lane use and pedestrian signal heads as the City directs.

1327.07 Five Section Traffic Signal Assembly. Ensure that all traffic signal heads comply with the requirements of section 1327.01, Vehicular Traffic Signal Head. Construct the assembly as shown in the TRAFFIC AND ROAD OPERATION STANDARD DRAWING ES-3-5. The Traffic Services Bureau supervisor, phone number 513-352-3712, must approve the completed signal assembly before installation.

1327.08 Method of Measurement. Signal heads are measured as complete units in place and accepted, including all support and mounting hardware, optical programming as plans specify, aiming, lamps, tether cable as specified and covering.

1327.09 Basis of Payment. City will make payment at the Contract unit price bid for each signal head as plans specify; payment includes all labor, material, tools, equipment, and incidentals necessary to furnish and install the item complete, tested and accepted.

Item	Unit	Description
1327	Each	Vehicular Signal head, assembly ____ Section, ____ inch lens, ____ way.
1327	Each	Optically programmed Signal head assembly ____ Section, 12 inch lens, ____ way.
1327	Each	Lane Use Control Signal head assembly ___ Controlled ___ face.
1327	Each	Lane use control signal head assembly, ____ inch ____ lens, ____ way.
1327	Each	Pedestrian Signal head assembly, ____ type ____.

ITEM 1328 Traffic Signal Detectors

1328.01 Detector Amplifier, Installation Only. The work of this item consists of hauling and installing detector amplifiers as plans specify, as the City of Cincinnati furnishes, in accordance with the plans and details. Install the amplifiers in the traffic signal controller cabinet, or separate cabinet if plans specify, and make all wiring connections in accordance with the details.

1328.02 Detector Pavement Cutting. Saw slots in the pavement for installation of wire for vehicle detector loops in accordance with the configuration dimensions, and combinations plans show. Before saw cutting the slot, make 1-1/4 inch (30 mm) diameter drilled holes in the pavement at each intersection of saw cuts to prevent sharp bends of the wire. Overlap the intersection of saw cuts so that the slots have full depth and a smooth bottom. Install the detector loop in clear, dry weather and ensure that the sawed slot is completely clean of dust and debris and thoroughly dry. Cut an extension from the loop to the pavement edge to permit wire routing to an adjacent pullbox or conduit fitting. When going through curbs, use Item 1321.04 PVC conduit to take the wire from the pavement edge through the curb and on into the pullbox or conduit fitting. Where no curb is present, end the sawcut six inches (150 mm) before the pavement edge at which point the wire routs through Item 1321.04 PVC conduit to an adjacent pullbox or conduit fitting.

Make the slot width 3/8 inch (10 mm) and slot depth four inches (100 mm) in asphalt, and two inches (50 mm) in concrete, with the minimum depth providing a covering above the uppermost wire in the slot of no less than one inch (25 mm) in concrete and three inches (75 mm) in asphalt. If floating of the wire occurs, bend one inch (25 mm) of 1/4 inch (6 mm) O.D. vinyl tubing and wedge it into the slot at two-foot (600 mm) centers to keep the wire down.

Following pavement cutting and cleaning, install the detector wire according to Item 1323.01.

Where the saw cut crosses any construction joint or cracks in concrete or asphalt pavement, drill a 1-1/2 inch (40 mm) diameter hole at the joint and provide a relief loop for the detector wire. Use installation methods and materials as details indicate.

Seal slots with a flexible embedding sealant approved by the City Traffic Engineer and as details indicate. Make the sealant an epoxy type: "Goldflex" as Preco or an approved equal manufactures. Before applying sealant, brush or blow clean all slots of loose material, and dry completely. Mix and place the sealant according to the Manufacturer's instructions. Fill the slots completely and leave them undisturbed until cured. Remove any excess or spillage.

Saw detector wire installations in new asphalt and embed with sealant in an undersurface course with subsequent covering by the surface course, subject to the Engineer's approval. Do not make detector wire installations in existing brick or unstable bituminous roadways.

Test the loop detector wire in accordance with Item 1313 before and after applying loop sealant.

City will include payment for the sealant in the Item of Saw Cutting.

1328.03 Loop Detector Installed In Duct. The Work of this item consists of installing conduit in areas trenched for this purpose or under new concrete roadway, whichever plans specify.

Where the plans require installation of duct in trenched areas, the work includes Item 1321.02 trenching in paved areas to the depth and width specified, and installing Item 1321.04 PVC conduit Type I concrete encased, formed in the dimensions plans specify. For loop detector

wire, use multi-conductor traffic signal cable, as plans and details specify, installed in the conduit and spliced to form multi-turn loops in the specified pullbox or conduit fitting. Item 1323 Loop detector wire shall be a separate pay item. This work also includes restoration of the paved area in accordance with Item 1334.

Where the plans require installation of duct under new concrete roadway, include Item 1321.04 - two inch (50 mm) PVC conduit Type II - formed in the dimensions plans specify, and include the applicable Item 202 for removing and disposing of existing pavement and Item 451 for installing new concrete pavement without reinforcing where these items are not included under roadway items. Additional items may be required contingent on the conditions and shall be specified.

City may make payment for each item required or on a lump sum basis as specified.

1328.04 Overhead Microwave Detector, Installation Only. The work of this item includes installing overhead detectors with cable, which the City furnishes in accordance with the plans, and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of Contract.

1328.05 Overheight Infrared Detector. The work of this item includes installing overhead detectors with cable, which the City furnishes in accordance with the plans and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of the Contract.

1328.06 Video Detection. The work of this item includes installing overhead detectors with cable in accordance with the plans and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of Contract.

A. General.

1. This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using only video images of vehicle traffic utilizing video transmission between the camera sensor and video detection processor.

2. Provide video detection system consisting of video cameras, a video detection processor and odd numbered phase extension modules which mount in a standard input file of a 170 controller, a pointing device, cabling, and camera attachment mounting hardware.

3. Include software that detects vehicles in multiple lanes using only the video image. Define detection zones using only an on board video menu and a pointing device to place the zones on a video image. Provide system with up to 24 detection zones per camera available. Provide system that does not require a separate computer to program the detection zones.

B. Functional Capabilities.

1. Furnish processor that detects the presence of vehicles in up to 24 detection zones per camera. A detection zone is approximately the width and length of one car.

2. Furnish system that permits the programming of detection zones via an on board menu displayed on a video monitor and a pointing device connected to the processor. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. Provide system that does not require a separate computer for programming detection zones or viewing system operation.

3. Provide system with processor capable of storing up to three different detection zone patterns and switching to any of the three different detection patterns within one second of user request via menu selection with the pointing device.

4. Provide system with processor that detects vehicles in real time as they travel across each detector zone.

5. Provide system with processor that has an RS232 port for communications with an external computer. Provide processor RS232 port that is multi-drop compatible.

6. Provide system with processor capable of accepting new detector patterns from an external computer through the RS232 port when the external computer uses the correct communications protocol for uploading detector patterns. Provide Windows-based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability with the system.

7. Provide system with processor capable of sending its detection patterns to an external computer through the RS232 port when requested when the external computer uses the correct communications protocol for downloading detector patterns.

C. Vehicle Detection.

1. Provide system that supports a minimum of 24 detection zones that can be sized to suit the site and the desired vehicle detection region.

2. Provide system where a single detection zone is capable of replacing multiple loops and detection zones may be AND'ed or OR'ed together to indicate vehicle presence on a single phase of traffic movement.

3. Provide system where placement of detection zones is done using only a pointing device and a graphical interface unit built into the processor and is displayed on a video monitor. Provide system that permits drawing detection zones on the video image from the video cameras and does not require a separate computer to program detection zones.

4. Provide system with processor capable of saving a minimum of three detection zone patterns within the processor memory. Provide process or with non-volatile memory that prevents data loss during power outages. Provide processor that continues to operate (e.g. detect vehicles) using the existing zone configuration even when the operator is defining/modifying a zone pattern. Provide system that does not put the new zone configuration into effect until the configuration is saved by the operator.

5. Furnish system that permits the selection of the detection zone pattern for current use through a menu or remote computer via RS232 port. Provide system that allows the activation of a detection zone pattern for a camera from processor memory and displays that detection zone pattern within one second of activation.

a. Provide system where the corners of the detection zone flash on the video overlay display screen to confirm the detection of a vehicle when the vehicle crosses a detection zone.

b. Provide system that is at least 98 percent accurate detecting vehicles in good weather conditions and at least 96 percent accurate under adverse weather conditions (rain, snow, or fog). Detection accuracy is dependent upon site geometry, camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.

c. Place detector so that the distance between the detector and the camera is not more than ten times the mounting height of the camera.

d. Provide system with processor capable of providing up to 24 channels of vehicle presence detection per camera through a standard input file edge connector and one or more extension modules.

e. Furnish system with processor capable of providing dynamic zone configuration to enable normal detector operation of existing channels except the one where a zone is being added or modified during the setup process. Furnish processor that outputs a constant call on any detection channel corresponding to a zone being modified.

f. Provide system such that detection zone setup does not require site specific information such as latitude, longitude, date and time to be entered into the system.

g. Provide system such that the processor outputs a constant call for each enabled detector output channel during the background learning period and if a loss of video signal occurs.

h. Provide system such that detection zone outputs are configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse extend and delay outputs shall be user definable between 0.1 and 25.0 seconds.

i. Furnish system such that up to six detection zones are capable of counting the number of vehicles detected. Furnish system that is capable of storing the count value internally for later retrieval through the RS232 port. Provide system that allows for the data collection interval to be user definable in periods of five, 15, 30 or 60 minutes.

D. Processor and Extension Module.

1. Design the processor and extension module to mount in a standard 170-type rack using the edge connector to obtain power and provide contact closure outputs. Furnish

processor or extension modules that can be mounted in a standard input file without the use of adapters and without rewiring.

2. Provide processors and extension modules capable of operating in a temperature range from –30° F to +165° F (-34° C to +74° C), and a humidity range from 0 percent RH to 95 percent RH, non-condensing.

3. Furnish processors and extension modules powered by 12 or 24 volts DC that automatically compensate for the different input voltages.

4. Furnish processors whose power consumption does not exceed 300 milliamps at 24 volts DC. Furnish extension modules whose power consumption does not exceed 120 milliamps at 24 volts DC.

5. Furnish processors that include a multi-drop compatible RS232 port for serial communications with a remote computer. This port shall be a nine-pin, "D" subminiature connector on the front of the processor.

6. Furnish processors that utilize flash memory technology to enable the loading of modified or enhanced software through the RS232 port without modifying the processor hardware.

7. Furnish processors and extension modules that include detector output pin put out compatibility with industry standard detector racks.

8. Furnish processors whose fronts include detection indications (such as LED's) for each channel of detection that display detector outputs in real time when the system is operational.

9. Furnish processors whose fronts include one or two BNC input connections suitable for RS170 video inputs as required. Provide video input that includes a switch selectable 75 ohm or high impedance termination to allow camera video to be routed to other devices, as well as input to the processor for vehicle detection. Video must be inputted via a BNC connector on the front face of the processor. RCA type connectors/jacks for video input are not allowed. Do not route video via the edge connectors of the processor.

10. Furnish processors whose fronts include one BNC video output providing real time video output that can be routed to other devices. An RCA-type connector/jack for video output is not allowed.

11. Furnish processors and extention modules whose front panel(s) have a detector test switch to allow the user to place calls on each channel. Provide test switch that is capable of placing either a constant call or a momentary call depending on the position of the switch.

E. Camera.

1. Furnish camera that is capable of producing a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of

scene luminance over which the camera shall produce a useable video image shall be the minimum range from night time to day time, but not less than the range of 0.1 lux to 10,000 lux.

2. Furnish camera that outputs monochrome video with resolution of not less than 350 lines vertical and 500 lines horizontal.

3. Furnish camera that includes auto-iris control based upon average scene luminance and is equipped with an auto iris lens.

4. Furnish camera that includes a variable focal length lens with variable focus that can be adjusted to suit site geometry without opening the camera housing. Adjust the lens iris to minimize image variations.

5. House the camera in an environmentally sealed enclosure. Equip the camera enclosure with a sun shield that prevents sunlight from directly entering the lens. Furnish sunshield that is less than six inches (150 mm) in diameter, less than 26 inches (660 mm) long and weighs less than 12 pounds (5.5 kg) when the camera and lens are mounted inside the enclosure. Include a thermostatically controlled heater in the camera enclosure to assure proper operation of the lens iris at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. Furnish camera that operates satisfactorily in a temperature range from –30° F to +130° F (-34° C to +55° C) and a humidity range from 0 percent RH to 100 percent RH when mounted outdoors in the enclosure.

F. Installation.

1. Furnish power cable that is 16 AWG, three-conductor cable based on a per foot price. Provide power cabling rated for 600 volts and RHH/RHW/USE insulated.

2. Provide coax cable that is high frequency, low-loss 75 ohm type with cable loss of no more than .78 dB/100 feet (30.5 m) at 10 MHz. Furnish cable suitable for installation in conduit or overhead with appropriate span wire. Use BNC plug connectors at both the camera and cabinet ends.

3. Furnish each camera unit with mounting brackets suitable for wood, steel pole, and other mast arm type applications. Include the brackets as incidental to the cost of the camera.

G. Warranty. Provide a limited two-year warranty from the Supplier for the video detection system.

H. Maintenance and Support. Include with the cost of the system a Supplier-lead training program consisting of two eight-hour training sessions that include field set up and installation instruction from a Factory Authorized representative. Provide Supplier-furnished trouble shooting and additional operational support by telephone and up to three field visits annually, throughout the duration of this Contract.

1328.07 Pedestrian Pushbutton With Associated Signs. Make pushbuttons of sturdy two-piece construction, consisting of an aluminum base housing and a vandal-resistant removable button/cover assembly with all other parts attached.

Provide button cover with bright red LED that flashes to acknowledge pushbutton activation. Construct button of 316 stainless steel and design to have a maximum operating force of three pounds (1.4 kg). Furnish base housing with captive stainless steel nuts to secure button cover assembly by using 1/4-20 stainless steel mounting bolts. Design and construct pushbutton to be approximately 3.4 inches (86 mm) in diameter and 2.5 inches (64 mm) deep when assembled. Design and construct pushbutton to operate in temperatures ranging from -30° F to 165° F (-34° C to 74° C) at a voltage range of 15 to 36 volts AC or 12 to 28 volts DC.

Ensure that the housing has a curved back surface for mounting on poles of various diameters. The curved surface may be integral with the housing or may be on an adaptor supplied with a flat back type housing. Attach the cover assembly to the housing with stainless steel machine screws, resulting in a weatherproof and shockproof design. Provide a hole threaded for a 1/2-inch (12 mm) pipe in the housing upper and/or lower sides to attach the conduit.

Orient push buttons as plans shown. Service pushbuttons mounted on steel poles by wiring inside the poles, as plans detail. Provide holes 3/4 inches (20 mm) in diameter throughout the back of the housing and the pole wall, install an insulated bushing, and route wiring through so that no external wiring is visible. Plug the unused conduit attachment hole(s). Make housing mounting as details show. Service pushbuttons mounted on wooden poles through conduit and mount them as plans show.

Furnish pushbuttons with two instruction signs, one mounted below the pushbutton and one mounted across the street on top of the complemented actuated pedestrian signal. Make mounting details and locations as details and plans show.

Make the sign below the pushbutton an R-73A-MOD-5, nominally five inches by eight inches (125 mm x 200 mm) containing the legend: "TO CROSS STREET PUSH BUTTON WAIT FOR WALK LIGHT" arranged as plans show.

Make the sign above the pedestrian signal an R-73B-MOD-18, nominally 18 inches x 24 inches (450 mm x 600 mm) containing the legend: "PUSH BUTTON FOR WALK LIGHT" arranged as plans show.

Ensure that signs meet the requirements of Item 1329.03.

1328.08 Method of Measurement. Measure detector amplifiers as complete units in place, connected, tested and accepted.

Measure detector pavement cutting as the total number of feet (meters) of slots from the edge of the pavement to the magnetometer probe locations or to the loop and around the loop perimeter using the overall dimensions and making no adjustments for the diagonal corners. The work includes the application of sealant, and cleaning and blowing out the slotted areas.

Measure loop detector installed in duct as more than one specified pay item (i.e. conduit, trenching paved areas, concrete, or conduit, excavation and new pavement). The measurement would then be comprised of each of the items specified

OR

Measure loop detector installed in duct as a complete item per square foot (m^2) of area for installations under new pavement or as linear feet (meters) excavated and restored. For installations in trenched areas, each detector includes all conduit trench-paved areas, excavation, restoration and concrete Class C as required. Payment would be made as "Loop Detector Installation".

Measure overhead Microwave Detectors as a complete unit, including all mounting hardware.

Measure overheight Infrared Detectors (two-eyed) as one complete installation, including all mounting hardware.

Measure pedestrian pushbutton with signs as a complete unit in place, including all hardware, tested an accepted.

1328.09 Basis of Payment. City will make payment at the Contract unit price bid as specified per each item and as full compensation for all labor, materials, tools, equipment and incidentals necessary to furnish and install the items as specified, complete, tested and accepted and in accordance with the details.

Item	Unit	Description
1328	Each	___ detector amplifier, installation Only
1328	Ft (m)	___ detector pavement cutting
1328	Ft^2. (m^2)	___ Loop detector installation, with new pavement
1328	Ft. (m)	Loop detector installation in trenched area
1328	Each	Overhead microwave detector installation
1328	Each	Overheight infrared detector
1328	Each	Pedestrian pushbutton with associated signs
1328	Each	Video Detection

Item 1329 Traffic Control Signs and Installations

1329.01 Internally Illuminated Signs. This work consists of furnishing and installing internally illuminated signs with one or more plastic faces in accordance with these specifications and as plans and details show.

This specification covers the fabrication of internally illuminated signs and includes the sign frame, lamp holders, ballasts, terminals, wiring, and mounting hubs. The nature of the construction of these signs and the need for them to accept lamps and lexan sign faces, requires that samples be provided before an award is made. This specification does require that the sign cabinets have rounded corners and "U" channels to accept lexan sign faces that have two thicknesses, depending on the sign size and also that have 1-1/2 inch (38 mm) radius corners.

Sign that are constructed with square corners and thus that require square sign faces, but otherwise meet the requirements of this specification and specifically that do not have hinged type doors as a means of access, may be considered as meeting this specification. Samples of any square cornered signs shall be made available within two weeks of the bid, with any resubmitted corrections made 30 days after they are requested.

A. Definitions.

Signs - Means the entire assembly including frame, permanently attached aluminum face for single-faced sign, mounting hubs, top frame reinforcement, lamps, lamp holders, ballasts, terminals, and wiring.

Frame - Means the members forming the top, ends and bottom enclosure of the sign.

Faces - The sides of the sign that face traffic.

Plastic Face - The entire assembly of plastic and paint forming the complete sign face.

Background. - The main panel of plastic which slides into the U grooves of the sign case and on which all specified legends are placed.

Legend - Letters, numbers, emblems, route markers, lines and/or arrows forming message.

B.. Sign Design. The illuminated sign is an all-aluminum box designed and constructed so the sign, complete with face or faces, will hang plumb when suspended.

1. Cast-Mechanical Construction. All metallic parts are of aluminum of 0.100 inches (2.5 mm) thick at all points. The aluminum is of high strength alloy type at least equal in strength and abrasion resistance to 3003H14.

2. Wind Load. The material, design and construction is such that the case will withstand continuous wind loads up to 30 psf (1,500 Pa).

3. Construction. Construct case to the size shown on the plans and Table 1329.A. A single-faced sign is designed for one plastic face and one permanently attached aluminum face. A double-faced sign is designed for two plastic faces. Plastic faces are retained in "U" shaped tracks designed to permit easy removal of the faces by sliding them out of the case on side or at the bottom for legend changing and electrical maintenance.

Design and construct sign so that this is accomplished without having to swing open a hinged door, and is instead achieved by removing one side of the channel that holds the actual sign face in place. The sign face thickness tolerance for all signs with a short dimension of 30 inches (760 mm) or less is 0.125 inch to 0.150 inch (3.2 mm to 3.8 mm). The sign face thickness tolerance for all signs with a short dimension of 36 inches (914 mm) or more is 0.187 ich to 0.200 inch (4.7 mm to 5.1 mm). All sign faces have 1-1/2 inch Construct the "U" shaped tracks to allow easy installation of sign faces constructed to these tolerances.

Table 1329.A – Sign Dimensions and Mechanical Data

Size Designation	Case Inside Diameter (Nominal) Modify to Accommodate Tube Length		Frame Cross Section Flange Depth		Overall Thickness of Complete Sign		Number Of Mounting Hubs (c)	Ballast Code Number (a)	Lamp Code	Number of Lamps (b)
	Horizontal	Vertical	Minimum	Maximum	Minimum	Maximum				
24" x 30" (600 mm x 760 mm)	24 inches (600 mm)	30 inches (760 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	1	ASB-0620-24-BL-TP	F24T12CWHO	4
30" x 24" (760 mm x 600 mm) 30" x 24" D	30 inches (760 mm)	24 inches (600 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	1 – SF 0 - DF	ASB-0620-24-BL-TP	F24T12CWHO	4
30" x 36" (760 mm x 900 mm)	30 inches (760 mm)	36 inches (900 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	1	ASB-0620-24-BL-TP	F36T12CWHO	4
36" x 30" (900 mm x 760 mm)	36 inches (900 mm)	30 inches (760 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	2	ASB-0620-24-BL-TP	F36T12CWHO	4
36" x 36" (900 mm x 900 mm) 36" x 36" D	36 inches (900 mm)	36 inches (900 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	2 - SF 2 – DF	ASB-0620-24-BL-TP	F36T12CWHO	4
48" x 48" (1,200 mm x 1,200 mm) 48" x 48" D	48 inches (1,200 mm)	48 inches (1,200 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	2 - SF 2 - DF	ASB-0620-24-BL-TP (2 each)	F48T12CW	6

(a) Numbers are those of the Advanced Ballast Company stated as a guide only.
(b) Lamps mounted vertically or at 45° from vertical shall have a rubber sleeve at the bottom lamp base.
(c) Mounting hubs are for 1-1/2 inch pipe size. Mounting hubs for mounting on a 4 inch post is required on the bottom and/or bottom corner of the sign.
(d) Measured with plastic at 70° F (21° C).
(e) Diamond shaped signs (with D on size designation) are square turned at 45° angle.

Table 1329.B - Sign Face Dimensions

Size Designation	Visible Plastic Face Area (Minimum)		Plastic Face Dimensions				Plastic Face Thickness		Plastic Face Corner Radius
			Horizontal		Vertical				
	Horizontal	Vertical	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
24" x 30" (600 x 760)	22-1/2" (572 mm)	28-1/2" (725 mm)	23-11/16" (602 mm)	23-3/4" (603 mm)	29-11/16" (754 mm)	29-3/4" (755 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
30" x 24" (760 x 600 mm)	28-1/2" (724 mm)	22-1/2" (572 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	23-11/16" (602 mm)	23-3/4" (603 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
30" x 36" (760 x 915 mm)	28-1/2" (724 mm)	34-1/2" (876 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
36" x 30" (915 x 760 mm)	34-1/2" (876 mm)	28-1/2" (724 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
36" x 36" (915 x 915 mm) 36" x 36" D(a) (915 x 915 mm)	34-1/2" (876 mm)	34-1/2" (876 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
42" x 36" (1,070 x 915 mm)	40-1/2" (1,029 mm)	34-1/2" (876 mm)	41-9/16" (1,056 mm)	41-5/8" (1,057 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 30" (1.220 x 760 mm)	46-1/2" (1,181 mm)	28-1/2" (724 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 36" (1,220 x 915 mm)	46-1/2" (1,181 mm)	34-1/2" (876 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 48" (1,220 x 1,220 mm) 48" x 48" D(a) (1,220 x 1,220 mm)	46-1/2" (1,181 mm)	46-1/2" (1,181 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)

(a) Diamond shaped signs (with D on size designation) are square turned at 45° angle.
(b) Lamps mounted vertically or at 45° from vertical shall have a rubber sleeve at the bottom lamp base.
(c) A mounting hub for mounting on a 4 inch post is required on the bottom and/or bottom corner of the sign.
(d) Measured with plastic at 70° F (21° C).
(e) BO designation indicated blankout type sign.

The frame is of an extrusion, casting, or formed member having one-piece cross section with flanges on both ends. It is at least as rigid as an extrusion of this design. The flanges are of "U" type specified for plastic faces and of either the "U" type of the single-flange type for attachment of the aluminum sheet for the blind side of single-faced signs. The frame and aluminum faces have continuously welded seams and are watertight.

The flanges serving as retainers for all faces have a radius of 1-1/2 inches (40 mm) at each corner of the sign. The top of the case frame is reinforced with a piece of 1/8 inch (3 mm) thick aluminum, continuously welded to the inside of the frame, extending the full width inside the frame flanges and running the full length of the frame top. All 24 x 24D, 36 x 36D and 48 x 48D signs are reinforced with 1/8 inch (3 mm) thick aluminum, continuously welded to the inside of the frame extending the width inside the frame flanges and extending up each side, at least 18 inches (450 mm), from the bottom corner. This welding reinforces the top to prevent deformation caused by the stress induced through the mounting hubs, when installed.

Drill four 1/4 inch (6 mm) weep holes, two on each end of the bottom of the frame, except on the 24 x 24D, 36 x 36D, and 48 x 48D signs, which have two weep holes drilled in the bottom corner.

D. Mounting. Attach to the top of the frame the number of 1-1/2 inch (40 mm) pipe size flanged pipe hubs Table 1329.A specifies for mounting purposes.

Paint the hubs the same color as the frame with the threads unpainted and the cable entrance through the hubs.

E. Fastening Devices. All nuts, bolts, screws, and rivets are of stainless steel or high strength silicon bronze.

F. Brightness. Take brightness readings at 118 input line voltage after the first 100 hours of lamp operation with a white plastic face of ROHM & HAAS Plexiglass No.7328 that will be provided by the City. Divide the plastic face into four inch by four inch (100 mm x 100 mm) rectangles and take one reading in the center of each rectangle. Make readings -in foot lamberts (candela per m^2).

AVERAGE BRIGHTNESS - (B_{AVG}) = The sum of the individual brightness readings divided by the number of readings taken.

MAXIMUM BRIGHTNESS - (B_{MAX}) = The largest reading taken.

MINIMUM BRIGHTNESS -(B_{MIN}) = The smallest reading taken.

RANGE OF AVERAGE BRIGHTNESS - (**R**) = a percentage calculated as follows:

$$R = 100 \times \frac{B_{MAX} - B_{MIN}}{B_{AVG}}$$

VALUES - THE VALUES ARE AS FOLLOWS:

	Minimum	**Maximum**
Average Brightness (B_{AVG})	130	190
Range of Average Brightness (R)	55%	

G. Component Mounting. Mount components inside the sign so that no shadows or dark spots appear on the sign face when the sign is illuminated.

H. Lamps. (Furnish signs with lamps.) Design signs for use with standard universally available T-12 cool white slimline fluorescent lamps in accordance with Table 1329.A.

I. Lampholders. Furnish lampholders constructed of white high-impact plastic with each set consisting of a male and female end. Provide lampholders rated for 660 watts and 600 volts of the two pin, recessed type. Furnish lampholders conforming to Leviton models 465 and 484 or approved equal. Lampholders at the low-voltage end of the lamp are the short-circuiting type, and at the high-voltage end are rated at not less than 600 volts. At the low voltage end, wire the lampholder with the ground conductor so that the primary circuit of the ballast is open when removing any lamp. If the lampholder on only one end of a lamp has a spring, the spring is in the top lampholder for vertically mounted tubes.

J. Ballast. Furnish class P, Type HL, high power factor series ballast that contains no PCB's and is type 2 outdoor compatible. Provide Advance Ballasts System model ASB-0620-24-BL-TP or approved equal. Furnish weather-resistant ballast that gives reliable starting at all ambient temperatures above 20° F (-7° C). Mark the ballast with the following information:

1. Manufacturers' name or trademark and catalog number.
2. Input voltage, frequency and current rating.
3. Open-circuit voltage, power factor and ballast loss (watts).
4. Number of laps, nominal lamp current, lamp length and type.
5. Wiring diagram indicating the correct electrical connection of various leads.

When located on the bottom of the sign, mount ballast on spacers to provide ½ inch (12 mm) clearance with the bottom and bolt it to the bottom of the case using four bolts. When located in other positions in the case, locate the ballast so as to minimize the effect of the weight of the ballast on the balance of the sign and the ability of the sign to hang plumb.

Make lamp and Ballast to be High Output (HO) with F24T12CW/HO tube and 120 volt, 4 tube ballast.

When located on the bottom of the sign, mount ballast on spacers to provide ½ inch (12mm) clearance with the bottom and bolt it to the bottom of the case using four bolts.

K. Terminal Block. Locate a terminal block having a minimum of four terminals near the cable entrance. Terminate wires for interior power connections on this terminal block. No external wires are supplied.

L. Wiring. All wiring shall be appliance Wire No. 18 AWG, with at least 16 copper strands and thermoplastic insulation at least 2/64 inch (0.8 mm) thick, and insulation rated for 221° F (105° C). Color code all wires with white used for the ground wire and color-code wires for the ungrounded wires of the supply circuit. The secondary circuit or high voltage circuit corresponds to the color-coding of the ballast leads. Run wire neatly in an aluminum raceway or flexible aluminum conduit and the edges of the openings in sheet metal or conduit, which offers protection from abrasion by means of a bushing grommet or rolled edge. Securely clamp or reliably hold in place the conduit at all openings and support the wiring so that the bottom of a sign is cleared by not less than 1/2 inch (12 mm).

Make splices mechanically and electrically secure with an acceptable splicing device.

Confine ballast lead splices to the ballast junction boxes and the raceway.

Do not strip the insulation on the wires at connection points any further than is necessary. Bare conductor does not overhang the edge of the base to which it is connected. Make wires fastened to lampholder terminals mechanically and electrically secure.

M. Marking. Mark each sign case on an inside surface with the Manufacturer's name and the date manufactured.

N. Painting. Prime the interior and exterior of the case, and bake the unit after each coat.

1. Exterior: Paint the exterior of the cabinet and the mounting hub black in accordance with Federal Color No. 17038.

2. Interior: Paint the interior a non-yellowing white in accordance with Federal Color No. 17875.

O. Plastic Face.

1. Material. The face is of cast translucent plastic of acrylic resin type matching the following Rohm and Haas Plexiglass Nos. numbers in weathering, structural, and optical properties or a Lexan material where plans specify:

White	W 7328
Yellow	2016

Material is of the thickness Table 1329.B specifies.

2. Legend. Apply a painted legend using a brand of paint the plastic Manufacturer specifies, using the silk screen or spray latex process. Over the painted legend, apply a clear protective coating of a brand the plastic Manufacturer specifies. Show face designs and colors as details specify.

Provide black painted legends, when plans specify, are opaque.

Red, green and blue painted legends, when plans specify, are translucent, of a type which will transmit an amount and color of light which is not distinguishable from the light transmitted by the materials plans specify.

The Red, green and blue painted legend, when plans specify match the following Rohm & Haas numbers in optical properties:

Red	2214
Green *	2280
Blue	2114

* Except street name signs (see Paragraph "P").

P. Street Name Signs. Make street name sign faces Lexan or approved equal. The text consists of white letters on a dark green background. The white letters and numbers require a vinyl type translucent paint. The background dark green conforms to Federal Color #14109.

Q. Installation. Include mounting hardware in the item furnished and as indicated in Table 1327 for the mounting arrangement plans indicate. Make the installation and all hardware in accordance with the requirements of the details.

Except street name signs (see Paragraph "P").

1329.02 Mechanically Operated Vane Type Signs.

A. General. The sign consists of two electrically driven hinged outer panels (vanes), which close over a center panel or open to expose the sign face. The outer panels open and close through 180°.

Make the "Blank Out Type" a single message type so that when the outer panels close over the center panel, no message is visible. When the outer panels open, both the outer and center panels form the specified sign face.

Make the "Dual-Message Type" a two-message type so that the movable panels when open form one sign face with the center panel as the open blankout type, and when the movable panels close over the center panel form a second message with the extended portion of the center panel. This type requires that the center panel extend to line up with the opened movable panels and with the movable panels painted on both sides.

B. Sign Face Blank and Panels. Make the sign face and panels a minimum 0.125 inch (3 mm) thick 6061-T6 aluminum with radius corners. Properly degrease the aluminum and etch or treat it with a light, tightly adherent amorphous chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B449-67, Class 2, 10-35 mg per ft^2 (110-380 mg per m^2) with a median of 25 mg per ft^2 (270 mg per m^2) as the optimum coating weight. The sign forms an essentially plane surface when opened.

C. Sign Face. The sign when opened, or closed, if bearing dual messages, accommodates the standard designs of Manual on Uniform Traffic Control Devices. Make the sizes 24 inches by 24 inches (610 mm x 610 mm), 24 inches by 30 inches (610 mm x 760 mm), 30 inches by 30 inches (760 mm x 760 mm), 30 inches by 36 inches (760 mm x 915 mm) as plans specifiy. Message, border and background color conforms to the Manual on Uniform Traffic Control Devices.

The face is reflectorized with the sheeting, painted and sealed with a clear coating.

D. Frame. Make the frame 0.250 inch x 1 inch x 1 inch (6 mm x 25 mm x 25 mm) 6061-T6 aluminum angle with 0.125 inch (3 mm) aluminum brackets with standard hub holes and one wire hole. Make the frame and brackets of welded aluminum construction.

Enclose the sign-activating mechanism in a corrosion-resistant box, constructed of a minimum of .060 inch (1.5 mm) 3003 H-14 aluminum with a housing cover of minimum 0.125 inch (3 mm) 300 H-14 aluminum. The enclosure meets NEMA 3R requirements for raintight applications.

E. Working Mechanism. The mechanical drive mechanism consists of a roller chain drive, cam- driven, self-locking device with positive drive on both cycles with spring override. All working parts are to be cadmium-plated steel. The motor is magnetic brake non-reversing, gear reduction type, 115 volts three amp developing minimum torque of 170 lbs. (230 N-m) at six to eight RPM, with direct drive from output shaft to operating cam. Provide a microswitch rated for 15 amps at 115 volts.

Enclose the motor in a galvanized steel cover positioned below the sign drive mechanism, with the gear reduction drive protruding through the housing to connect with the cam.

Make all screws, bolts, nuts, sprockets and washers cadmium-plated steel.

Make the chain drive 1/4 inch (6.5 mm) pitch cadmium-plated steel-rolled chain.

Hinges consist of three pivot points on each panel. Make pivots of cadmium-plated steel and attach them with bolts to threaded holes to the panels. Pivots have brass bushings.

F. Mounting. The mounting assembly consists of mounting brackets or hubs, with 1-1/2 inch (38 mm) pipe arms and "U" or saddle clamps for securing the sign assembly to a post or drop pipe (with weather head) as plans specify.

Make at least two mounting assemblies with the material constructed as follows:

1. U-Clamp - Construct of 3/16 inch (5 mm) cadmium or zinc-coated steel and bracket with formed radius as plans specify, with 1/2 inch (12 mm) "U" volt of welded construction or painted cast iron of equal strength and design.

OR

2. Sign Mounting Clamp - Welded construction with 3/8 inch (10 mm) "U" bolt and full grip clamp, with 1-1/2 inch (38 mm) standard tubing and 10-gauge steel plate or cast iron of equal strength and design, with standard hub hole pattern.

3. Hub - Plate is 10 gauge steel or cast iron of equal strength and design, with standard hub hole pattern, welded 1-1/2 inch (38 mm) standard pipe collar or nipple.

Where plans specify span wire or mast arm mounting, provide a 1-1/2 inch (38 mm), schedule 40, galvanized steel pipe of the length required, a weatherhead and balance adjuster and span wire suspension clamp or mast arm bracket. Install the assembled sign shall be installed as details show.

G. Miscellaneous Requirements.

Provide complete sign units weighing not more than 55 pounds (25 Kg) each.

Construct units so that the open or closure time through 180° less than six seconds.

Enclose mechanism and protect to function in a wide range of environmental conditions including rain, snow, wind and temperatures from -40° F to 150° F (-40° C-70° C).

Construct units so that the sign does not normally require periodic lubrication, cleaning or seasonal adjustment.

Do not damage the sign by forcing the panels open or closed within normal operating range.

1309.03 Signs, Flat Sheet Type. Signs not required to be internally illuminated are of the flat sheet type fabricated from aluminum, painted and reflectorized in accordance with Item 630; Reflective green sheeting, Type G.

Signs are in accordance with the standard designs of the Manual on Uniform Traffic Control Devices and of the size and legend plans and details indicate.

City will make payment for mounting hardware and installing signs under the specified attachment.

1329.04 Sign Attachments.

A. General. The work of this item consists of furnishing and installing the sign provided under Item 1329.03, with the hardware as specified for the type mounting attachments. Install the sign and attachment assembly in accordance with the plans and details.

B. Span Wire Mounted Sign Attachments. The work of this item includes steel drop pipe, span wire suspension clamp, weatherhead and balance adjuster, lead slug, pipe cap, and pipe straps and hardware.

C. Mast Arm Mounted Sign Attachments. The work of this item includes steel drop pipe, lead slug, pipe cap and straps, mast and clamp and hardware.

D. Bridge or Wall Mounted Attachments. The work of this item includes angle brackets, anchoring hardware and miscellaneous hardware.

E. Plague Attachments. Where plans specify a reflectorized sign (or plaque) attached to an illuminated sign and/or traffic signal head, such sign attachment, which includes all hardware required for the attachment, is incidental to the payment of the illuminated sign and/or traffic signal head.

Sign notes and quantities indicate payment and quantity for the reflectorized sign.

F. Materials. All hardware and materials required are of the non-corrosive materials as details specify.

1329.05 Method of Measurement. Measure internally illuminated and mechanically operated vane type signs as a complete unit in place, including all lamps (for illuminated signs), sign faces with the specified legend(s), all components and mechanisms and all mounting hardware.

Measure signs, flat sheet type, as the actual number of square feet of signs furnished, erected, and accepted. Determine measurement for square, rectangular, circular, or irregular shaped signs by multiplying the largest dimensions of width and height. Determine measurement for triangular shaped signs by multiplying the largest dimension of width and one-half the largest dimension of height.

Measure sign attachment assemblies as complete units by type, furnished and installed complete in place and accepted with the specified sign(s) included but furnished under its own item of payment. This includes all clamps, pipes, hangers, brackets, hardware and incidentals as indicated for each type.

1329.06 Basis of Payment. City will make payment at the Contract unit price bid as each item specifies, and as full compensation for all labor, materials, tools, equipment and incidentals necessary to furnish and install the items as plans specify, complete, tested and accepted.

Item	Unit	Description
1329	Each	Internally illuminated sign, ___ face, ___ inches x ___ inches.
1329	Each	Mechanically operated vane type sign, ___ type, ___ inches x ___ inches.
1329	Ft^2 (m^2)	Signs, flat sheet type.
1329	Each	_____ mounted sign attachment.

Item 1330 Pavement Marker Buttons and Longitudinal Channelizing Systems

1330.01 Pavement Marker Buttons. The marker is a snowplowable type unit constructed of cast iron with an acrylic prismatic reflector. Implant the unit in the roadway and secure with an epoxy adhesive.

Provide markers that are Stimsonite Model 96 or 96 LP as plans specify, or an approved equals.

The work of this item includes pavement cutting using a concrete saw with a multiple blade arrangement to provide a cut to match the contour of the marker housing.

Clean and dry the sawed excavation using a brush or air blast from a compressed air source.

Pour and mix epoxy adhesive in accordance with Manufacturer's instructions.

1330.02 Longitudinal Channelizing Systems. This specification covers a longitudinal channelizing system that consists of three components. The first component is a series of interlocking, raised separator units that help keep moving traffic along a particular path. The second component is a high target vertical marker that attaches to the separator units. The final component is a profile reflector that enhances the reflectivity of the system. The entire system, when installed, provides a traffic lane barrier that keeps vehicles within their lanes, while allowing an emergency vehicle the ability to go over the barrier at lower speeds.

1330.03 Raised Separator. Provide raised separators consisting of two basic units: a separator unit and an end unit. Fabricate the raised separator of recycled plastic with a sufficiently durable mass to achieve a weight of at least ten pounds per linear foot (15 kg per meter). Provide separators that are a minimum of ten inches (255 mm) and a maximum of 12 inches (305 mm) in width, and a minimum of 3-1/2 inches (90 mm) and a maximum of four inches (100 mm) in height with a cross section that is gently curved so as to provide minimal resistance to vehicle tires, thereby allowing emergency vehicles to cross the separator. To increase target value in daylight hours, provide separator with the entire rounded surface colored white or yellow to conform to the traffic pavement markings that they supplement.

For ease of installation, provide the raised separator units in portable sections, 3.33 feet (1 meter) in length. Furnish units that structurally fasten together securely by bolting each unit to a connecting metal device molded securely into the adjoining unit. Use tapered end units at the beginning and end of each run of separator to form a gradual increase in height from the pavement level to the top of the separator. Provide tapered end units 1.5 feet (460 mm) in length that are capable of receiving a reflecting element. Fix the separator to the roadway by removable expansion anchors spaced as recommended by the separator Manufacturer. Provide the anchors and include their cost in the unit price for the separator units.

Provide individual separator units that have a receptacle for the installation of a bow shaped device with retro-reflectivity on the top and sides facing motorists.

Provide raised separator system capable of being deployed without being anchored to the roadway by fasteners. Furnish molded in metal connecting devices capable of holding the individual separator units together and in position on the roadway without the need for fasteners. Additionally, furnish system capable of being installed, removed and shifted from one lane to the next via a truck mounted conveyor system.

1330.04 High Target Value Channelizers. Affix each high target value channelizer to a detachable flexible rubber boot or other device that supports the channelizer in a vertical position, and is capable of restoring the channelizer to the vertical position if struck by a vehicle. Furnish channelizers composed of high impact plastic that accommodates Type III retro-reflective sheeting. Generally, provide reflective sheeting of the same color as the raised separator units.

Use elliptical channelizers when traffic is moving generally parallel to the traffic separator. Mount elliptical channelizers between 40 and 47 inches (1,015 and 1,195 mm) above the roadway and between eight to ten inches wide. Provide elliptical channelizers that accommodate retro-reflective Type III sheeting between 29 and 30 inches (740 and 760 mm) in height and between 7-3/4 and eight inches (197 and 203 mm) in width providing a reflective area of 230 to 255 square inches (0.15 to 0.16 m^2) facing the traffic. Install markers along the length of the separator system to provide an on-center spacing of approximately 6.7 feet (2 meters).

Provide round channelizers that are between four and six inches (102 and 152 mm) in diameter. Furnish round vertical markers that have an overall round appearance so that reflective sheeting is visible from any direction around the round channelizer. Round vertical markers must accommodate at least two four-inch (102 mm) bands of reflective sheeting providing a retro-reflective area of 50 to 100 square inches (0.03 to 0.06 m^2) facing traffic. Mount round channelizers at a height of 40 to 44 inches (1.0 to 1.1 meters) above the roadway. Install the round markers along the length of the separator system to provide an on-center spacing of approximately 6.7 feet (2 meters).

1330.05 Reflecting Element. For motorist safety at night, reflecting elements must depict the raised profile of the separator units at night. Thus, design reflecting elements to adhere to the top and both sides of the separator units. Design snap-in arcs with seven reflecting elements on each side to depict the raised profile of the lane separator and install on each separator unit as well as each male end unit. Provide individual reflective "cat's eyes" that

have the following photometric performance data in millicandela per lux (mcd/lux) for the inclination angle of 0°:

Angle of Observation α	Entrance Angle β	White (mcd/lux)	Amber (mcd/lux)	Red (mcd/lux)
0.3°	5°	140	70	28
0.5°	10°	90	45	18
1.0°	10°	36	18	7.2
2.0°	15°	4.6	2.3	0.9

1330.06 Warranty. Vendor certifies that the Manufacturer of the system will provide a a 100 percent Manufacturer's warranty for damage to the raised separator units, end units and reflecting elements for the first two years against all normal vehicular roadway traffic, and the same pro-rated warranty averaging at least 50 percent of the replacement value for three additional years. The Manufacturer must also warrant the system components to be free from defects in workmanship and material for a period of two years from the date of shipment. Vendor must provide a copy of the Federal Highway Administration (FHWA) approval letter accepting the Longitudinal Channelizer system's NCHRP350 test results. Failure to include these warranties will result in the bid being deemed non-responsive. For the safety of the motoring public and to establish cost worthiness, the separator system must have a minimum of three years of on-road experience.

1330.07 Method of Measurement. Measure pavement marker buttons as a complete unit in place, including sawcutting, cleaning and epoxy adhesive. Measure raised separator unit including tapered end sections by the linear feet (meters) completed and accepted in place. Measure the channelizers (elliptical and round) by the number of each completed and accepted in place.

1330.08 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, furnished and installed and in full compensation for all labor, materials, tools, equipment, and incidentals necessary for a completed and accepted item.

Item	Unit	Description
1330	Each	Pavement marker button, ___ type
1330	Linear Foot (meter)	Raised Separator unit, (white / yellow), including tapered end sections and matching reflecting element.
1330	Each	Channelizers, elliptical, (white / yellow), including reflective sheeting
1330	Each	Channelizers, round, (white / yellow), (with/without) matching reflective band.

Item 1331 Traffic Island Lighting

1331.01 Traffic Island Lighting. The City will furnish traffic island light equipment. Where plans specify an overhead type, the City will furnish the fixture complete with lamp. Where plans specify the pedestal type, the City will furnish the globe fixture complete with lamp.

Before pouring the concrete for the construction of the traffic island, coordinate the casting of the cone type fixture and/or pedestal anchor bolts, and connection of conduit from the island light to the specified pull box. Install a ground rod in the nearest pullbox as details show.

Include the conduit, ground rod and pedestal (where plans specify) under each item of bid, but include with the pedestal bid item conduit ells where pedestals are located adjacent to pullboxes. Provide pipe fittings and hardware for mounting the pedestal fixture to the post.

1331.02 Method of Measurement. Measure traffic island lights as a complete unit in place, including pipe fittings, nipples and all hardware required to mount the fixtures.

1331.03 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, installed complete, tested and accepted and as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1331	Each	Traffic island light, ___ type, installation only

Item 1332 Relocation of Existing Equipment

1332.01 Relocation of Existing Equipment. Equipment plans specify to be relocated may be poles, signs, signal heads, luminaires, island lights or other. Carefully remove the specified equipment and relocate the equipment where plans indicate.

After removal, equipment shall be inspected and cleaned. Remove any rusted areas, spot prime and paint in accordance with Item 1317.

When relocating poles and posts, provide new anchor bolts conforming to Item 1318 which the payment of the item relocated shall include. Ensure that new foundations for relocated poles and posts are in accordance with the plans and details. City shall make payment for foundations per Item 1319.

When relocating signs, signal heads or other specified devices, furnish new materials and hardware as required to properly reinstall the equipment complete and in accordance with the details. Contractor may reuse salvageable materials with the Engineer's approval. Redlead the new pipe threading when reusing drop pipe and arms by reducing the length. Where existing drop pipe and arms are too short, furnish new pipe. The City will not permit extension pipe pieces with couplings.

Include new hardware and materials required in the payment for the item relocated and make them of non-corrosive material in accordance with the details.

In rewiring relocated equipment, use entire new cable runs or extensions of existing cable as plans specify. Splice new cable to existing cable using approved splicing as details indicate. Remove or abandon existing cable as plans specify; disconnect abandoned cable completely at both ends. Cut the ends cut so that existing conductor ends are not exposed beyond the insulation. The conductors are then doubled back over the jacket and taped with at least three layers of approved weatherproof electrical tape.

Furnish new cable under the respective Item 1323.

Relamp signal, sign and luminaires after reinstallation. Include lamps with the payment of the item relocated and ensure that they meet the requirements of the application under Items 1326 and 1329.

1332.02 Method of Measurement. Measure relocated equipment as a complete unit by type in place, tested, and accepted and include relocating, rewiring, splicing and new and/or modification of existing hardware, lamps, painting and removal and disposal of unusable materials and equipment and new anchor bolts for poles and pedestals.

1332.03 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, relocated complete, tested and accepted as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1332	Each	Relocation of existing ___ (specified equipment)

Item 1333 Modification of Existing Lighting Circuits

1333.01 Modification of Existing Lighting Circuits. Where plans specify, provide labor and materials to modify and reconnect the specified lighting circuit complete as plans and details indicate.

Schedule work so as not to disable the existing lighting circuit during the hours when the circuit is normally operative.

Ensure that all materials and equipment used meet the requirements of the items as specified herein.

1333.02 Method of Measurement. Measure modification of existing lighting circuits as complete units in place, tested and accepted, including all materials and equipment as plans specify.

1333.03 Basis of Payment. City will make payment at the Contract unit price bid for each circuit modified complete, tested and accepted and as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1333	Each	Modification of existing lighting circuit No. _____ .

Item 1334 Restoration of Work Areas

Keep adequate walking areas for pedestrians clear of equipment, materials, supplies and excavated materials at all times.

Move any excavated material obstructing any portion of the sidewalk or street area at the end of the working day so as not to obstruct the sidewalk or street area.

Adequately barricade and light excavated material off of, but not adjacent to the sidewalk area.

Neatly restore sidewalks, driveways, and sodded areas to the satisfaction of the City. Restoration of paved areas in accordance with the City of Cincinnati, Engineering Division "Street Restoration Book" as Cincinnati Municipal Code, Section 721-35 stipulates.

Contractor may remove forms in accordance with 511.14. Remove all forms before backfilling. Do not use excavated material as backfill unless the Engineer approves. Place backfill in layers and compacted to prevent future settlement of backfill materials. Dispose of the excavated material not needed and backfilled.

Restore all sodded areas using excavated material with the top four inches (100 mm) of restoration being topsoil compacted to grade.

Furnish well-rooted Kentucky Bluegrass or Canadian Bluegrass containing a growth of not more than 30 percent of other grasses and clovers, unless plans specify otherwise.

Restoration is incidental to the payment of the various item requiring restoration.

Item 1335 Cable and Pole Identification

Identify all lighting cable by circuit with tags in accordance with Item 713.18. Identify using adhesive decals with reflective characters and background installed as details show.

The City furnishes pole decals, and the Contractor furnishes circuit cable tags.

Providing and installing these items is incidental to the payment of the cable and poles.

Item 1336 Method of Payment

City will make payment for accepted quantities of street lighting and traffic control items provided in these specifications at the prices the Contract specifies.

Method of Payment will be one of the following:

A. Unit price for each item.

B. Lump sum for the entire Contract (by location or circuit).

C. Lump sum for the entire Contract with unit prices for major items to cover possible changes of quantities, which may arise during the Contract period.

The enclosed specification items are based on unit price bidding, with the Contractor furnishing all materials and equipment except that which is specified as furnished by the City. Where the City specifies in a Contract that it will furnish equipment, make adjustments for bidding these items where the work is reduced to installation and materials required to complete the item of work.

Where the City specifies that the Contract (by location or circuits within a Contract area) will be bid on a lump sum basis, the basis of payment includes all accepted quantities of equipment and materials as plans specify, as required to provide a complete item, in place, tested and accepted. The basis of measurement includes the work requirements of all the various items required.

Item 1337 Turn On-Off Records

Notify the City Traffic Engineer and provide a written record thereof when turning on or off any electrical operated lighting and traffic control device, and when installing and removing all electrical and non-electrical devices.

This is to provide the City of Cincinnati with information for public record and for purposes of energy billing.

The record shall show the time of day and the date. This information shall also include dates for burn tests.

The City will make payment incidental to items so noted.